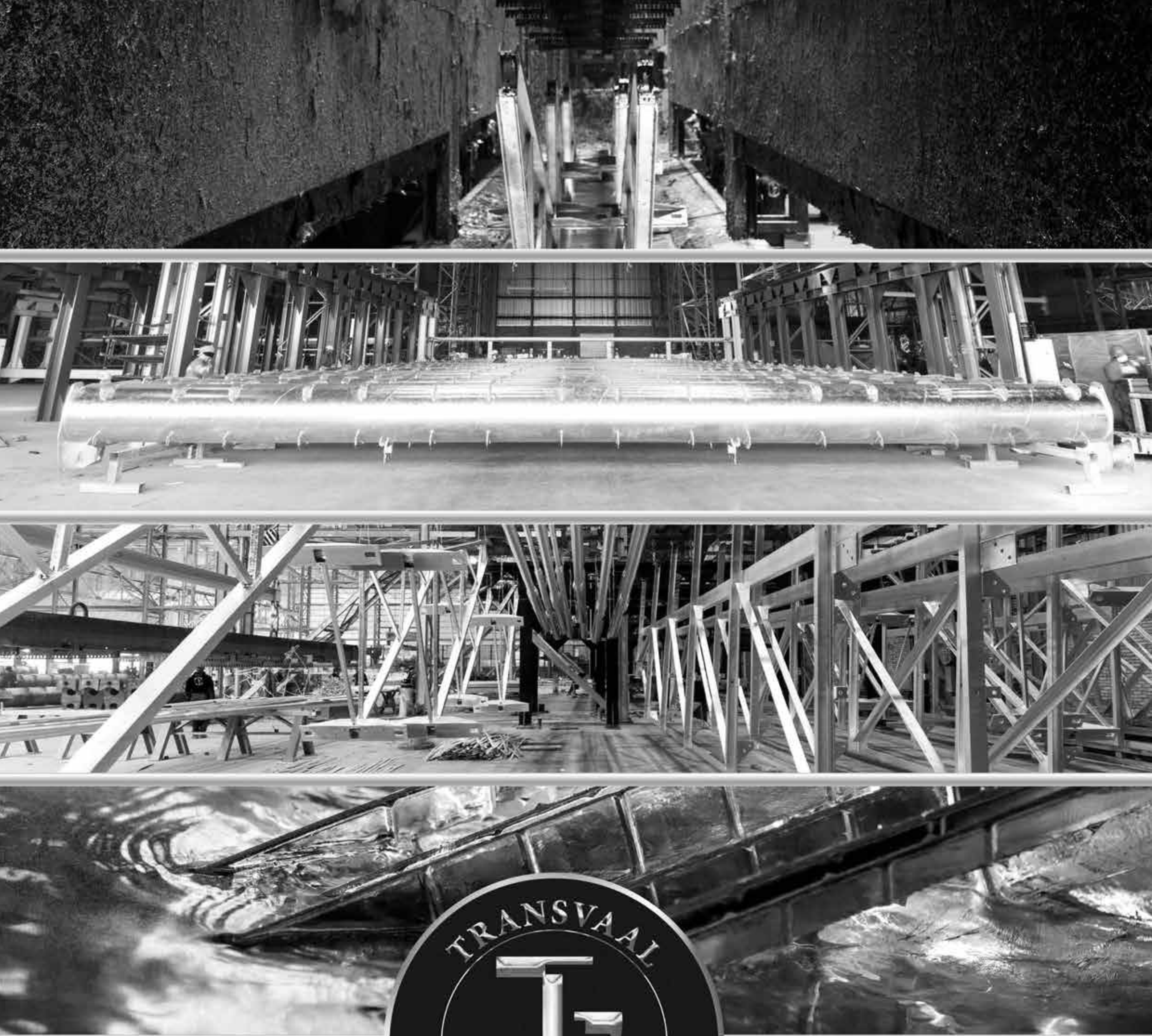
Volume 18 Issue 2
May / June 2021

HOT DIP GALVANIZING TODAY 77

The Official Publication of the Hot Dip Galvanizers Association Southern Africa

STANDARDS

CORROSION CONTROL OF STEEL



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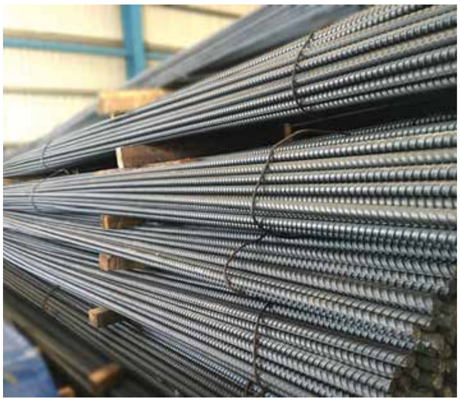

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Contents

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

ISSN 1023/781X

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EXECUTIVE DIRECTOR'S
Comment

If the past months have taught us anything, our belief in the use of "Standards" has been reinforced.

It is most important that a purchaser of a commodity or service is specific about his or her requirements and expectations. Of equal importance is that the seller is accurate in terms of what they will supply. In the less regimented worlds than Engineering, Construction or Manufacture, consensus between parties may be reached through agreements concluded after looking at pictures, sketches, or merely verbal discussion about what is to be purchased and what will be supplied.

However, in an environment where functionality and safety are paramount, the price to pay for misunderstandings can be enormous.

Driven strongly by the need to eliminate such errors, standards have been devised for virtually all components, processes and test regimes related to the disciplines mentioned. This ensures that these are all well- defined, and that all relevant pass/fail criteria are clearly spelt out.

Despite the above, the Association has spent a significant amount of time "untangling" disputes related to variations between expectation and performance.

An analysis of why this has occurred leads me to conclude that specifiers are often unaware of the existence of the detail offered by standards. As an example, what is meant by the term galvanizing, or more specifically, hot dip galvanizing? A partial summary of some products that are hot dip galvanized may prove to be useful:

- Batch type hot dip Galvanizing for fabricated iron and steel article – SANS121:2011-ISO1461:2009.
- Best practice when fabricating iron and steel components are defined in SANS 14713 PARTS 1 and 2.
- Continuous galvanizing of sheet and coil, often for profiling into roof sheeting – ISO 4998
- Tubes and pipes hot dip galvanized through a controlled, wipe process – SANS32 – En 10240:1997
- Hot dip galvanizing of friction grip fasteners – ISO 10684

Within each of these standards are clearly defined specifications related to coating mass, coating appearance and most importantly test methods for acceptance criteria.

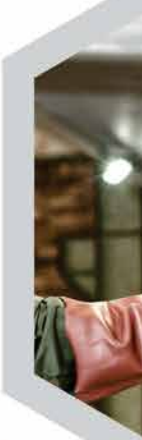
In addition to these product related standard, environmental considerations, and probable rates of corrosion for various metals in different environments can be found in ISO 9223. Similarly, service life estimates for different paint systems are given in ISO 12944.

For any corrosion control option chosen by the engineer, architect or person responsible for a project specification, a wealth of information is at hand to ensure a good specification and most importantly to provide us with standards against which go/no go decisions may be made.

Of particular concern to the Association during the recent months has been a sharp increase in both poor quality and inappropriately specified roof sheeting. Coil profiled for roof sheeting applications and sold on price rather than against specified standards has failed prematurely on several projects. Another issue of concern is the marketing and sales of zinc electroplated fasteners as "galvanized" fasteners. Here the differential in coating mass between a plated and dipped fastener may be a factor of five and hence able to deliver five times the coating service life.

It may be tempting in these stressed times to attempt to stimulate work by cutting prices. Too often however low margins are wiped out through quality errors or premature product failures. So, to ensure success in project execution, the correct product specifications must be applied and product testing for compliance to these specification is vital.





EDITORIAL COMMENT
in this issue

"Build to a standard, not a price" said Henry E. Steinway. This is music to the ears of professionals. Millennials, Baby Boomers, Generation X – The reassessment of where and who we are and where we want to be always requires collaboration. The core of collaboration between wide groups of participants can only occur when all work to an agreed set of standards. The standard is the single most important element from which all parties can proceed. The need for standards has never been more pressing than now. With less face to face time, more technological intervention and a need for a singular outcome standards will always be necessary.

- The standards we work to in South Africa and the benefits from understanding them are critical in growing a professional, articulate and succesful future for all those involved in manufacturing and the downstream activities akin thereto.
- The largest galvanized steel storage tank and the way forward.
- TCI, CSSA, and ACMP are now collaboarative entities combined to form Cement & Concrete SA.
- Innovation to de-dross with savings to the galvanizer is put forward as a solution to this long time challenge of zinc consumption in galvanizing kettles.
- Warpage and distortion, guidelines for preventing the unwanted stress relieveing.
- A specifiers checklist for galvanizing provides peace of mind to first time and longterm hot dip galvanizing users.

The Hot Dip Galvanizers Association Southern Africa (HDGASA) is a not-for-profit trade organization, founded in 1965, dedicated to serving the needs of end-users, specifiers, architects, engineers, contractors, fabricators and hot dip galvanizers throughout Southern Africa.

To further this aim, the Association provides advisory involvement, training and information by way of courses, workshops, specialized presentations on corrosion control, technical research papers and case studies of hot dip galvanizing's effectiveness at corrosion control.

The Association liaises with regulatory and standards authorities governing the corrosion control and associated industries. The HDGASA provides services for independent inspection against relevant standards and reviewing compliance against the relevant standards by the stakeholders in the industry, and provides applicable analysis through metallurgical and SANAS approved analytical laboratories.

The Galvanizing Members of the HDGASA represent the majority of the hot dip galvanizing fraternity both by mass and value in sub-Saharan Africa. Through close liaison with the EGGA, AGA, Australian Galvanizers and associated organizations the HDGASA maintains a global presence and participates in arenas of common interest including the ISO standards.

The HDGASA publishes supporting literature such as our *Steel Protection Guide, Design Wall Chart* and *Facts about Hot Dip Galvanizing*. These are used effectively to bring third parties with little or no knowledge of hot dip galvanizing up to speed with the technology.

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ARMCO Randfontein	011 693 5825
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Pro-Tech Galvanizers	011 814 4292
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STANDARDS –
A means to provide reliable, sustainable solutions

STANDARDS ARE A "COMMUNICATION" TOOL THAT ALLOWS ALL USERS TO SPEAK THE SAME LANGUAGE ABOUT PRODUCTS OR PROCESSES. THEY PROVIDE FOR LEGAL, OR AT LEAST ENFORCEABLE, MEANS TO EVALUATE ACCEPTABILITY AND SALE-ABILITY OF PRODUCTS AND/OR SERVICES.

Ultimately standards are a means to protect a purchaser from questionable designs, products and practices. They provide the means by which engineers can best meet environmental, health, safety and societal responsibilities.

Roughly 80% of global merchandise trade is affected by standards and by regulations that embody standards. Standards and conformity assessment programs play a key role in the transfer of technology ultimately to ensure success in the marketplace.

They can be learnt and applied globally. Industry participation in the standards development process is essential.

Standards should be part of a life-long learning process. Check often for changes as they will affect your products and processes as an engineer, manager and end user. Find out what Standards are appropriate to your project or product and include these appropriate Standards a part of your specification.

Understanding which standards are applicable and how they are used is critical to the quality of the outcome and expectations of all stakeholders. The poor habit of 'cut-and-paste'-specifications, when it comes to standards will inevitably give rise to unscheduled delays and challenges which could have been easily avoided at the outset.

Standards can:

- Maintain uniformity in product quality,
- Reduce unnecessary duplication,
- Lower costs,
- Improve productivity,
- Ensure safety,
- Simplify product development,
- Permit interchangeability, compatibility, and interoperability,

- Enhance the acceptance of products and much more.

Standards are typically designed for voluntary use and do not necessarily impose any regulations. However, laws and regulations may refer to certain standards and make compliance with them compulsory. Any standard is a collective work.

The South African Bureau of Standards (SABS) has been mandated to produce standards in South Africa. SABS is a statutory body that was established in terms of the Standards Act, 1945 (Act No. 24 of 1945) and continues to operate in terms of the latest edition of the Standards Act, 2008 (Act No. 8 of 2008) as the national standardisation institution in South Africa, mandated to:

- Develop, promote and maintain South African National Standards (SANS);
- Promote quality in connection with commodities, products and services;
- Render conformity assessment services and assist in matters connected therewith.

Committees of manufacturers, users, research organizations, government departments and consumers work together to draw up standards that evolve to meet the demands of society and technology. SABS Standards' staff act as secretaries to these committees and project manage the production of standards. Crucial to this process are 450 technical committees and subcommittees that are responsible for developing standards. At present, more than 6100 standards are maintained by SABS Standards Division and new standards are developed at a rate of approximately 500 a year.

The Standards watchdog, in the South African context, is SANAS (South African National Accreditation System). SANAS is responsible for carrying out accreditations in respect of conformity assessments mandated through the Accreditation for Conformity Assessment, Calibration and Good Laboratory Practice Act (Act 19 of 2006). They are directed and legally represented by a Board of Directors whose members are appointed by the Minister of Trade and Industry. This Board delegates to the Chief Executive Officer (CEO) of SANAS the responsibility to implement the SANAS policies and objectives. The CEO delegates decisions concerning the granting, extending, suspending or withdrawing of accreditation to the Approval Committee Chairperson. SANAS operates in accordance with the requirements, criteria, rules and regulations laid down in the following documents:

- The Accreditation for Conformity Assessment, Calibration and Good Laboratory Practice Act, 2006 (Act 19 of 2006).
- The requirements of the international standard ISO/IEC 17011: Conformity Assessment – General Requirements for Accreditation Bodies Accrediting Conformity Assessment Bodies.
- The requirements as stipulated in the various Memorandums of Agreement with the international bodies and the national regulatory bodies.

SANAS grants accreditation, certification and the scope of accreditation for Conformity Assessment Bodies (CAB's). In the fields of hot dip galvanizing the following CABs include but may not be limited to:

- SABS COMMERCIAL SOC LTD FAN*: C07a
- SANS 121
- SANS 32
- SANS 675
- SOUTH AFRICAN TECHNICAL AUDITING SERVICES (PTY) LTD FAN*: C25
- SANS 121 addendum 8
- SANS 10244-2 addendum 21
- SANS 675 addendum 19

**FAN = Facility Accreditation Number*

Without standards there can be no objective assessment of quality and no means to provide customers with reliable, repeatable, predicable and sustainable solutions.

A SPECIFIER'S galvanizing checklist

THE ACHIEVEMENT OF A QUALITY HOT DIP GALVANIZED COATING, FOR GENERAL AND ARCHITECTURAL USE, IS DEPENDENT ON MANY ISSUES, SOME CONTROLLABLE AND SOME NOT. THIS CHECKLIST TACKLES THE ISSUES THAT CAN BE CONTROLLED BY THE SPECIFIER / DESIGNER AND THOSE CONTROLLABLE BY THE GALVANIZER.

The importance of lead times

In the case of large contracts, the galvanizer should be involved at the programming stage with the fabricator and the end user. Hot dip galvanizing is normally the final process after fabrication and prior to delivery and erection. If sufficient time for hot dip galvanizing, cleaning, fettling and inspection is not provided in the overall programme, costly delays may occur at the assembly stage.

Specifiers' galvanizing checklist

- Discuss requirements with the Galvanizers Association and/or the selected galvanizer/s before designing commences.
- The specifier or designer to ensure all steelwork contractors are informed in writing of the architectural hot dip galvanizing requirements prior to the finalization of the tender.
- Make the requirements known to the galvanizer, in writing, together with a sketch or sample, before placement of the order. Further discussion with the galvanizer may be required.
- Make use of the HDGASA wall chart – "Design for Hot Dip Galvanizing"
- Choose correct steel type. If possible all parties related to the project to purchase the specified steel from a reputable supplier. Insist on the steel chemical analysis certificates for the material being supplied, not just generic grade specifications, for record purposes and issue copies to the galvanizer.
- Ensure components can be dipped in a single immersion or alternatively discuss the impact of double end dipping with your preferred galvanizer / HDGASA.
- Optimize size of filling, draining and vent holes.
- Optimize position of filling, draining and venting holes.
- Should painting of the hot dip galvanizing be specified (Duplex System), ensure that instructions stating **"Do Not Passivate– Component is to be painted"**, is handed to the galvanizer, at order stage, unless specifically discussed and excluded.
- Select significant surfaces, highlight on drawing or sketch and discuss with galvanizer why these surfaces are considered significant to the article's functionality.
- If necessary, hot dip galvanize a sample and establish acceptance / rejection criteria which will be required over and above the SANS 121:2011 (ISO1461) standard.
- Specify the correct temporary-marking pen for fabrication marking – no paint or oil based marking pens should be used. If such are used the fabricator must remove all traces prior to

delivery to the galvanizer. Uncoated areas arising from such markings will require the article be rejected or a concession made by the end user to renovate such areas. Both of these options will add cost and a 'hassle' factor which can be easily avoided.

- Ensure that if permanent marking, such as welded lettering is used it will be appropriately hidden from final view.
- If deemed necessary, to minimize handling damage ensure correctly positioned lifting lugs are provided or if not acceptable, soft lifting slings are used, by all parties, including the galvanizer, the transporter, the site off-loader and the site erector, etc. The use of the former is possibly more appropriate.
- Specify welding that is fit for purpose; do not allow over welding.
- Should stick welding be used, ensure that all weld slag is comprehensively removed by abrasive blasting or grinding prior to delivery to the galvanizer. Excessive weld porosity can have a marked effect on the aesthetic of the hot dip galvanized article, which is not a cause for rejection i.r.o the standard.
- Some welding materials are metallurgically reactive with regard to hot dip galvanizing. Should aesthetics or excessive build-up of zinc at a weld be unacceptable for aesthetic reasons, ensure prior to welding that a suitable welding wire or rod be used by consulting a weld specialist.
- Simplify componentry – simple structures result in repeatable hdg coating quality.
- Complex structures are harder to manipulate in the galvanizing bath and as such may require more control, cleaning and fettling.
- Simplify complex structures by making use of bolting where possible or alternatively design for after galvanizing welding, by using a suitable masking material typically referred to as 'Galvstop', which can be easily cleaned, successfully welded and correctly renovated in accordance with the standard.
- Discuss packaging / dunnage requirements with the galvanizer required for transport and ensure that ample site stacking facilities are provided. A hot dip galvanized coating is applied in a facility and thereafter transported to site where frequently the components may be debussed by being 'thrown-off' the truck. Inappropriate offloading may lead to preventable mechanical damage of the coating. As the components are generally not wrapped, coating discolouration due to contaminants being deposited by wet trades, i.e. angle grinding of wet clay bricks in the presence of hot dip galvanized components, should be prevented.
- Discuss the appropriate repair method, if repair is deemed to be necessary, with the galvanizer. Silver spray paint is not acceptable. The silver spray paint may be initially more aesthetically acceptable while the hot dip galvanized coating may have a bright and shiny lustre, but will ultimately stand out and be aesthetically unacceptable, when the hot dip galvanized coating weathers to a matt dull grey patina of Zinc Carbonate. Furthermore it is unlikely that spray paints are able to meet the requirements of the standard to provide corrosion control protection as a two part zinc rich epoxy for renovation or repair purposes.
- Discuss the maximum size of coating repair allowable by the standard and what concessions will be allowable when alterations or adjustments are made on site, with the appropriate contractors.
- Discuss the requirement for acceptance inspection of the components while in the custody of the galvanizer. This will usually be at the galvanizer's facility. The repair, renovation or even re-galvanizing of components is better managed at that stage. Once the material leaves a galvanizer's custody additional costs will be incurred in the repairing of the hdg coating.
- Ensure that a certificate of conformance in accordance with the SANS 121:2011 (ISO 1461:2009) specification, has been obtained from the galvanizer.
- Ensure that SABS Mark accredited galvanizers use their appropriate identification paint, before delivering the components to site. Furthermore, identification paint is to be applied only to areas identified on the drawings by the architect or consultant or if not available in non-significant areas, particularly if the component is not to be over coated with a paint system.

DISTORTION and warping

When the decision is made to hot dip galvanize, the design engineer should ensure that the pieces can be suitably fabricated for highest quality galvanizing. Best practice suggests steel to be galvanized should be symmetrical and of similar thickness.

With proper consideration and understanding of how the hot dip galvanizing process affects steel, asymmetrical designs or structures containing sections of unequal thickness can be successfully galvanized, as can fabrications where cold-working techniques (bending, hole-punching, rolling, shearing) are employed.

Steel being galvanized progresses through a temperature cycle upon immersion into and withdrawal from the galvanizing bath. Because parts are immersed at an angle, uneven heating occurs, creating a temperature profile along the part being galvanized. This temperature profile allows the steel's internal stresses to be relieved at different times in the immersion cycle. These stresses may cause changes in shape and/or alignment (distortion and warping).

The following steps can be taken to *minimize* this risk:

- Where possible, use symmetrically rolled sections in preference to angle or channel frames. I-beams are preferred to angles or channels.
- Use parts in an assembly of equal or near equal thickness, especially at joints.
- Use temporary bracing or reinforcing on thin-walled and asymmetrical designs.
- Bend members to the largest acceptable radii to minimize local stress concentration.
- Accurately pre-form members of an assembly so it is not necessary to force, spring, or bend them into position during joining. Continuously weld joints using balanced welding techniques to reduce uneven thermal stresses. Pinholes from welding are very dangerous in items to be galvanized and must be avoided. Staggered welding techniques to produce a structural weld are acceptable. For staggered welding of 4mm or lighter material, weld centres should be closer than 100mm.
- Avoid designs that require progressive-dip galvanizing. It is preferable to build assemblies and subassemblies in suitable modules so they can be immersed quickly and galvanized in a single dip. In this way, the entire fabrication can expand and contract uniformly. Where progressive dipping is required, consult your galvanizer.

Consult your galvanizer regarding the use of temporary bracing or reinforcing.

CONSIDERATIONS BY FABRICATORS

to safeguard against warpage and distortion during hot dip galvanizing of steel assemblies

1. Scope

Steel assemblies and subassemblies fabricated by welding, such as composite structural members, sash, weldments, etc., that are to be hot dip galvanized after fabrication, are subject to warpage and distortion of the material due to the heating and cooling incidental to the galvanizing operation, particularly when it is necessary for the assembly to be dipped more than once to cover the entire surface.

2. Factors in warpage and distortion

2.1 One of the most commonly distorted and warped members of assemblies is that of sheets or plates from No. 20 gage ([0.812mm)] to ¼ in. (6.35 mm) in thickness which are assembled by welding or riveting to bar-size shapes, angles, channels, tees, etc.

2.2 Warpage is accentuated by the use of non-symmetrical sections such as channels. In nearly every case, regardless of size, channels require straightening after galvanizing. This is not true of an I-beam, pipe, H-column, or any other section that is symmetrical about both its major axes. Channels and other non-symmetrical sections should be avoided for the framework of a sheet metal assembly that is to be hot dip galvanized whenever it is possible to use symmetrical shapes or sections.

2.3 The use of wide radii bends in corners is recommended. In the case of sheet metal, the product which has a right-angle bend in the sheet metal itself will remain flatter and be freer from distortion if the radius of the bend is as large as practicable.

2.4 Certain welding practices, weld sizes and configurations, and thickness differences between welded components can introduce imbalanced stresses into the weldments. If these stresses are combined with other stresses during hot dip galvanizing, the stress relieving effect of galvanizing may permit distortion to occur.

2.5 When two pieces of steel are seal welded in an overlapping joint, the overlapping section must be properly

vented per. If the overlapped area is not properly vented or if it is incorrectly sealed, the pressure from the expansion of the trapped gases in the overlapped area can distort the two pieces of steel that are welded together and, in the worst case, can cause an explosion underneath the zinc bath surface destroying the parts and causing a potential safety problem at the hot dip galvanizing facility.

3. Suggested corrections for panel fabrication

3.1 The angles selected should be in as perfect alignment as it is practical to obtain.

3.2 Stiffening angles should be placed in position and held down to prevent their being moved when in contact with the electrode during the welding operation. In welding any intermediate lengths along one side of a common member, care should be taken to prevent warpage of the common member due to the application of high heat on the same side at various intervals along its length.

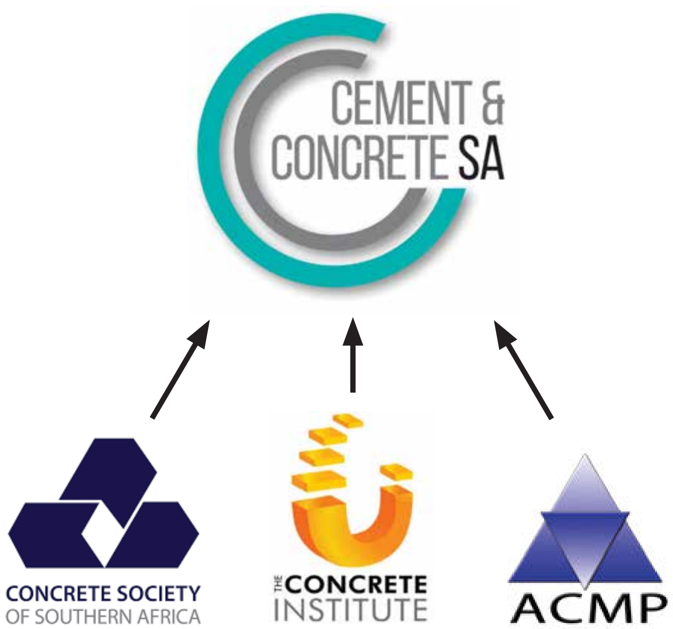
3.3 All edges of tightly contacting surfaces should be completely sealed by welding unless the area exceeds the recommended size detailed in ISO 14713. This will prevent the rusting of the surfaces which that are so connected that molten zinc cannot circulate through the crevices to galvanize the contacting surfaces.

3.4 The sheet steel should not be welded to the angle steel frame prior to galvanizing if the galvanizing kettle is not of sufficient size to permit the total immersion in one dip. If the frame has to be dipped one half at a time, it will be better to have the sheets galvanized, rolled flat after galvanizing, and assembled to the galvanized frame by the use of aluminium alloy or galvanized rivets. These rivets can be countersunk or flat head if the protruding head of the ordinary button or round head rivet is objectionable. If the angle steel frame and sheets are punched prior to galvanizing (the recommended procedure), the use of drift pins to bring the holes into alignment should be avoided as far as possible at the time the sheets and frame are assembled.

3.5 If the galvanizing kettle is of sufficient size to permit total immersion of the assembly in one dip, the riveting of fabricated parts prior to galvanizing is not recommended because contacting surfaces will not be coated and rusting will occur due to entrapped pickling acid.

3.6 Unequal thicknesses of metal should be avoided wherever possible due to the different rates of heating and cooling during the galvanizing operation and the effect of unequal expansion and contraction.

CEMENT & CONCRETE SA:
Unlocking new opportunities



The long-awaited cement and concrete industry body consolidation process has entered the home straight – *Cement & Concrete SA* officially launched on 1 March 2021.

Engagement with the various stakeholders from the cement and concrete value chains to gather information about the missions, value offerings, structures, operations and expectations, resulted in TCI, CSSA, and ACMP committing to be part of the consolidated Cement & Concrete SA.

The vision of Cement & Concrete SA (CCSA) is to be the unified voice of the cement and concrete industry in South Africa, defending and promoting the industry, driving growth and delivering shared value.

The current portfolio of services of TCI will remain, enhanced by added value offerings from CSSA and ACMP, all based on a new and inclusive membership model which will be communicated early in 2021.

Objectives

- Work with industry role players to develop the value propositions of cement and concrete
- Promote the value creation story of the cement and concrete industry in South Africa.
- Develop various membership options that are representative all industry segments and stakeholders.
- Grow membership of the CCSA in all membership categories.
- Support research as a means of increasing the ongoing relevance and efficacy of concrete.
- Promote industry standards and audit compliance amongst members and industry role players.
- Grow industry skills and build capacity by developing and offering manuals, courses, seminars and training materials.
- Provide information, research, advisory and on-site technical consulting services to members, government, standards authorities and the public.

Cement & Concrete SA will have a strong focus on committees to ensure that all relevant areas are addressed with expertise through consultation.

We believe that this will unlock new opportunities for all members, and the industry at large. We look forward to sharing more information soon and welcoming you to being part of the only official unified voice of the cement and concrete industry in South Africa.

HOT DIP GALVANIZING of rebar

Introduction

Repairing damage caused by corrosion in South Africa is estimated to costs around R13 750 000 000.00 a year.

A significant contributor to the corrosion predicament is decaying reinforcing steel bar (rebar), which produces red rust staining, cracking of the cover layer, and spalling of concrete structures throughout South Africa. Corroding rebar leads to costly repairs, continual maintenance, and eventual structural weaknesses of the concrete with potentially devastating results in the event of a catastrophic failure of a bridge or other large construction.

Hot dip galvanizing is commonly specified for its longevity and durability on exposed structural steel, it is, however also used to effectively and economically protect steel rebar in concrete from corroding.

Concrete is a porous material and corrosive elements from the atmosphere permeate the concrete, eventually reaching the steel rebar resulting in the corrosion of unprotected rebar.

Galvanized reinforcing steel, with its tenacious, durable hot dip galvanized coating, is uniquely suited to withstand these rigors without impediment to the concrete.

Rebar corrosion

Concrete contains small pores and capillaries through which corrosive elements such as water, chloride ions, oxygen, carbon dioxide, and other gases travel into the concrete matrix, eventually reaching the steel reinforcing bar. As the concentration of these corrosive elements increase, particularly chlorides, steel's corrosion threshold is eventually exceeded and rebar starts to corrode.

Rust, or iron oxide, is the result of an electrochemical process. When iron corrodes, its corrosion products (rust) are 2 – 10 times more voluminous than the original steel. This increase in volume around the steel rebar exerts great disruptive tensile stress on the surrounding concrete. Concrete exhibits good compressive strength, but has poor tensile strength, generally about one-tenth of the compressive strength. As pressure builds, the concrete will begin to crack *(Figure 1)*, creating a direct pathway for the corrosive elements, leading to accelerated rebar corrosion and eventual spalling of the concrete. Once cracking has occurred, the structural capacity of the element is compromised and costly repairs may be needed to extend its useful life.

How zinc protects steel from corrosion

Zinc, applied to steel in the hot dip galvanizing (HDG) process, has been used for more than 100 years to protect steel. When clean steel is immersed in a zinc filled galvanizing kettle, the iron in the steel reacts with the molten zinc to form a series of metallurgically-bonded, zinc-iron alloy layers *(Figure 2)*. These tightly-

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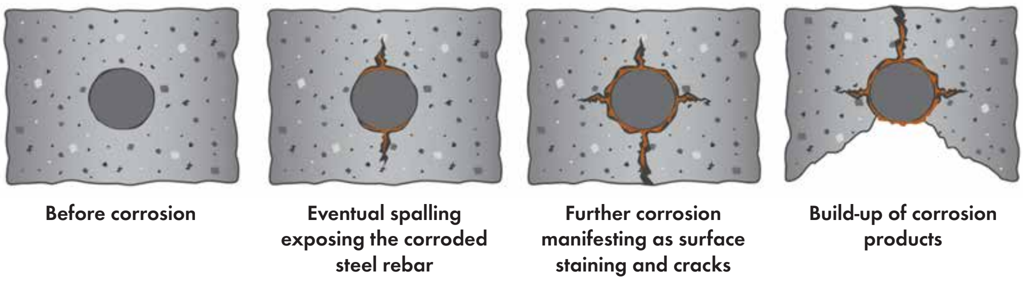

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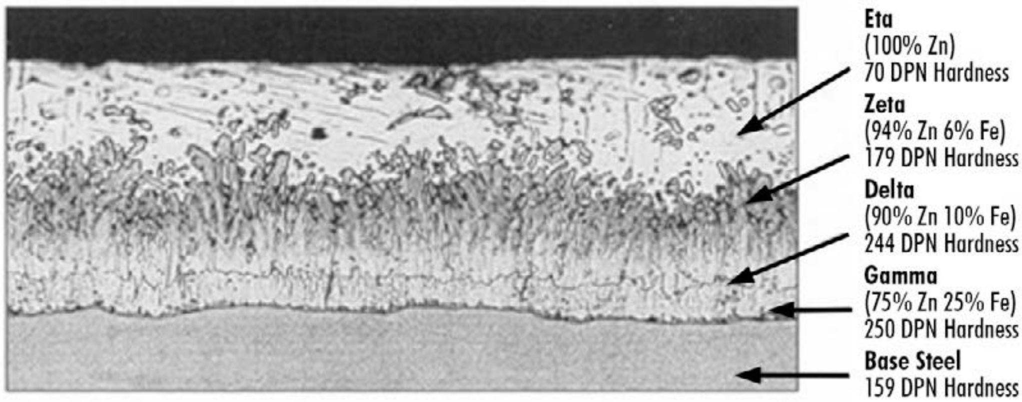

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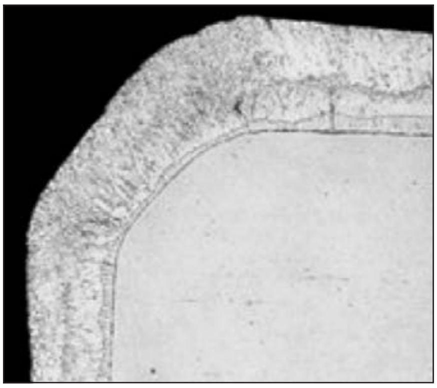

Figure 1: Spalling concrete.

Figure 2: Typical zinc-iron alloy layers (aluminium killed steel).

Figure 3: Uniform coating including corners.

bonded (~25 MPa) intermetallic layers are actually harder than the base steel and provide increased impact and abrasion resistance to the hot dip galvanized article.

During the reaction in the kettle, the alloy layers grow, in phases, perpendicular to all surfaces ensuring corners and edges have equal protection *(Figure 3)*. Additionally, the immersion process ensures complete coverage of the entire steel article's surface, including areas inaccessible or hard to reach with brush and spray applied coatings. This complete uniform coverage means the entire piece of steel is afforded barrier and cathodic protection – inside and out.

The hot dip galvanized zinc coating provides an impenetrable barrier, protecting the steel from corrosive elements in the environment. As the zinc coating is exposed to the environment, an additional barrier develops as zinc corrosion products form on the surface.

This naturally occurring zinc patina is tenacious and relatively insoluble, creating a passive, protective layer on top of the zinc coating which inhibits ongoing exposure and corrosion of the underlying galvanized coating. This protective zinc patina is why zinc's corrosion rate is estimated to be 1/10th to 1/100th that of the steel corrosion rate.

In addition to the complete coverage attained and the development of the zinc patina barrier, hot dip galvanizing also provides cathodic protection. Because of differences in electrical potential, zinc is anodic to steel, which means when the two metals are connected zinc corrodes preferentially, cathodically protecting the steel. Therefore, the hot dip galvanized coating cannot be undercut by rusting

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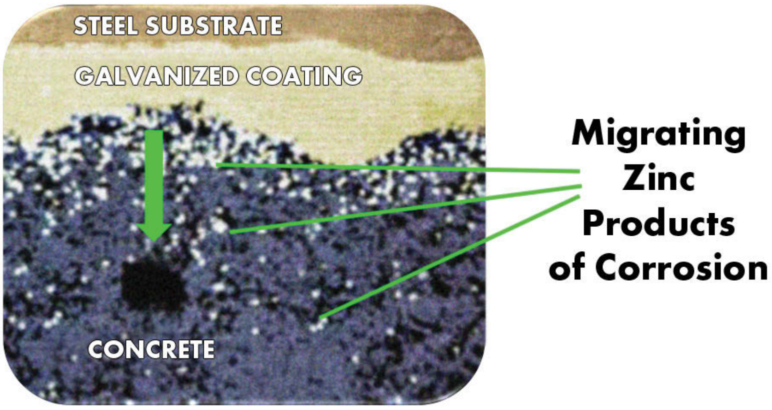


Figure 4: Elemental map of galvanized rebar in concrete.

steel, as is the case with paint coatings. Steel exposed at cut edges or from severe mechanical damage, will not corrode as the adjacent zinc will sacrifice itself and isolate corrosion until all of the surrounding zinc is consumed.

How galvanized rebar slows corrosion in concrete

The corrosion mechanisms and performance of black and hot dip galvanized steel in concrete are different than when exposed in atmospheric conditions.

Steel embedded in concrete is exposed to a highly alkaline environment. Black steel is passive in alkaline concrete until the chloride level exceeds approximately 600g/m^3, when steel becomes depassivated and starts to corrode. Zinc, on the other hand, can withstand chloride concentration at least four to five times higher than black steel, and coupled with its impervious barrier protection, delays the onset of chloride corrosion on galvanized rebar.

Chlorides penetrate the concrete through small pores and cracks that form on the surface through use and weathering. While black steel in concrete typically is de-passivated below a pH of 11.5, galvanized reinforcement can remain passivated at a lower pH, thereby offering substantial protection against the effects of concrete carbonation.

In addition to the higher chloride tolerance, once the zinc coating does start to de-passivate, the zinc corrosion products formed are less voluminous than iron oxides and actually migrate away from the galvanized bar into the matrix of the concrete *(Figure 4)*. Unlike the development of iron oxide, the migration of the zinc corrosion products from the rebar prevents the pressure build up and avoids the internal pressures that lead to concrete spalling.

The elemental map shows how the corrosion products of galvanized rebar being less dense do not build up the significant pressure required to cause concrete spalling. The zinc corrosion products (depicted in white), migrate away from the galvanized coating and disperse throughout the concrete matrix.

The total life of a galvanized coating in concrete is made up of the time taken for the zinc to de-passivate (which is longer than for black steel, because of its higher tolerance to chloride ions), plus the time taken for the consumption of the zinc coating as it sacrificially protects the underlying steel. Only after the coating has been fully consumed in a region of the bar will localized ferric oxide corrosion of the steel begin.

Mechanical properties of galvanized rebar

Ductility and yield/tensile strength

Studies of hot dip galvanizing on the mechanical properties of reinforcing steel show little effect on the tensile or yield strength or the ultimate elongation of rebar, provided appropriate steel selection, fabrication practices, and galvanizing procedures are followed.

When rebar is fabricated prior to hot dip galvanizing, bend radius should follow Table 2 of ASTM A767, Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement. If rebar is fabricated after galvanizing, standard industry practice, as per the Concrete Reinforcing Steel Institute's (CRSI) Manual of Standard Practice, should be followed.

Additionally, the effect of galvanizing on the ductility of steel bar anchors and inserts after being subjected to different fabrication procedures has been investigated. The study concluded with correct choice of steel and galvanizing procedures, galvanizing causes no reduction in the steel's ductility.

Fatigue strength

An extensive experimental program examining the fatigue resistance of steel reinforcement shows deformed reinforcing steel, exposed to an aggressive environment prior to testing under cyclic tension loading, performs better when galvanized.

Bond strength

Good bonding between reinforcing steel and concrete is essential for reliable performance of reinforced concrete structures. When protective coatings on steel are used, it is essential to ensure they do not reduce bond strength. Studies on the bonding of galvanized and black steel bars to Portland-Cement concrete have been investigated. The results of these studies indicate:

- Development of the bond between black or galvanized steel and concrete depends upon cure time and environmental factors.
- In some cases, the full bond for galvanized rebar may take longer to form than for uncoated steel, depending on the zincate/cement reaction.
- As reported by Stephen Yeomans in Galvanized Steel Reinforcement in Concrete, there are a number of studies that have concluded the fully developed bond strength of galvanized rebar has no significant difference from black rebar bond strength.
- A study by C. Andrade in Spain monitored bond strength of galvanized rebar samples over 10 years immersed in sea water and found no deleterious effects on bond strength over that time.

Zinc reaction in concrete

During curing, the galvanized surface of steel reinforcement reacts with the alkaline cement paste to form stable, insoluble zinc salts accompanied by hydrogen evolution. This has raised the concern of the possibility of steel embrittlement due to hydrogen absorption. Laboratory studies indicate liberated hydrogen does not permeate the galvanized coating to the underlying steel and the reaction ceases as soon as the concrete hardens. The reaction within the concrete requires that the hot dip galvanized reinforcement be chromate passivated after galvanizing.

It is necessary that the hot dip galvanized reinforcement be chromate passivated after galvanizing. Many cement mixtures contain small amounts of chromate that may serve the same purpose as chromate passivating the zinc coating. The reaction between the alkaline cement paste and the zinc coating is dependent on the amount of zinc coated surface in the concrete with the potential for reaction increasing with more zinc metal in contact with the concrete.

Design and fabrication

When galvanized steel is specified the design requirements and installation procedures employed should be no less stringent than for structures where uncoated steel reinforcement is used. In addition, there are some special requirements to be observed when galvanized steel is used. The following suggestions are intended as a guide for designers, engineers, contractors, and inspectors. They are intended as a supplement to other codes and standards dealing with the design and fabrication of reinforced concrete structures, and deal only with those special considerations that arise due to the use of galvanized steel.

Steel selection

Reinforcing steel can be referenced to the following informative standards as a guide to BEP:

- A 615: Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
- A 706: Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement

Detailing of reinforcement

Detailing of galvanized reinforcing steel should conform to the design specifications for uncoated steel bars and to normal standard practice. Overlap lengths of hot dip galvanized reinforcing steel are identical to uncoated steel rebar because of the equivalent bond strength to concrete.

Dissimilar metals in contact

Another design consideration when utilizing galvanized reinforcement is the possibility of establishing a bimetallic couple between zinc and bare steel (i.e. at a break in the zinc coating or direct contact between galvanized steel and black steel bars) or other dissimilar metals. This type of bimetallic couple in concrete should not exhibit corrosive reactions as long as the two metals remain passivated. To ensure no reactions occur, the concrete depth to the zinc/steel contact should not be less than the cover required to protect black steel alone under the same conditions.

Best practice dictates when using galvanized reinforcement, it should not be directly connected to large areas of black steel reinforcement, copper, or other dissimilar metals. Bar supports and accessories should be galvanized, and tie wire should be annealed wire – 1.3 mm Nominal Diameter or heavier – preferably galvanized. If dissimilar metals must be used, polyethylene and other, non-conducting tapes can be used to provide insulation between the metals.

Bending bars

Hooks or bends should be smooth and not sharp. When bars are bent cold prior to galvanizing, they need to be fabricated to a bend diameter equal to or greater than those specified SANS 282.

When bending after galvanizing, some cracking and flaking of the galvanized coating at the bend may occur. The speed at which the article is bent may also affect coating integrity. The galvanized coating is best maintained at slower bend speeds.

KROME INNOVATES TO SAVE ZINC

using K-Flux De-Dross product

by Courtney Orlik

Krome Metal Chemicals have invested in ongoing innovative developments aimed to improve current hot dip galvanizing processes by seeking solutions to old methods that are sustainable, environmentally friendly and offer Galvanizers an opportunity work with Krome in pursuit of cost-effective outcomes.

As such the development of a specialized molecular powder additive for kettles, K-Flux De-Dross Powder, to aid in drastically reducing zinc metal content in ash and dross removed from the zinc kettle was formulated.

Krome Metal Chemicals report that the Invert Dross, bottom dross, is also loosened from the kettle walls and floor with additions of the K-Flux De-Dross Powder. The reactive-agents allow for re-dissolving of 'captured' zinc and separating out iron pellets.

The challenges and factors that where considered by Krome when developing the K-Flux De-Dross product included:

1. Dissolved iron in flux solutions dries onto processed surfaces of parts and carries over to kettles, adding to impurities in kettle, creating dross. Iron levels should be kept between 0.1 – 0.9% in flux, never exceeding 1%.
2. Dross formation is created by influx of iron and high dross levels in the kettle itself, at these levels of dross, an accelerated process of corroding the kettle begins, influencing the energy needed to maintain fluidity and temperatures of kettle.
3. Large temperature fluctuations of the kettle due to increasing iron levels, creating another avenue for iron-zinc alloys to settle out to form dross.

Benefits claimed when using K-Flux De-Dross:

- Allows for improved, uniform coatings.
- Increases Fluidity of bath, increasing run-off, decreasing zinc pick-up rates.
- Ammonium Chloride Free Product, resulting in low smoking agent.
- Non-toxic/noxious powder, allowing for environmentally friendly option.
- Easy to use product, which can be continually added to line.
- Decreased Zinc removed in dross and increased removal of free iron.
- Less corrosion and temperature fluctuations on kettle.
- Allows for continuous production and prolongs the life of the zinc kettle by reducing heavy bottom dross volumes.

KROME METAL CHEMICALS' FINDINGS:

Typical Kettle Control Guidelines:

1. **Dross Generation: 0.6 – 0.8% per ton of steel processed.**
2. **Ash Generation: 0.2 – 0.4% per ton of steel processed.**

TRIAL TEST RESULTS ACHIEVED

Dross Composition prior to K-Flux De-Dross Treatment::

- **Zn: 97,6%**
- **Fe: 3,3%**

Dross Composition AFTER Treatment with K-Flux De-Dross:

- **Zn: 42,5%**
- **Fe: 25,4%**

FLUX bath control

THE FLUX WASH IS AN ESSENTIAL PART OF THE GALVANIZING PROCESS. ITS PRIMARY PURPOSE IS TO PROMOTE THE ALLOYING OF MOLTEN ZINC TO THE BASE METAL. GOOD FLUXING PRACTICE ENSURES A HIGH QUALITY COATING BOTH FROM THE STANDPOINT OF APPEARANCE, TIGHT ADHERENCE OF THE ZINC AND THE ABSENCE OF UNCOATED AREAS.

Introduction

Before fluxing the work will have been degreased, pickled and normally cold rinsed. Thus it should reach the flux tank clean and relatively free of oxides and iron particles. The flux wash deposits a film on the steel surface, which will not attack the iron itself but will prevent oxidation which would otherwise occur by exposure to the atmosphere during the interval between pickling and galvanizing. In actual practice, some oxidation does occur during this interval. However, when dried flux comes into contact with molten zinc, it immediately melts at the surface of the bath. In the melted state, the flux provides a final cleansing action which removes remaining oxides or iron salts.

Ideally, the flux bath is operated hot for more efficient fluxing and to effectively dissolve sufficient flux crystals so as to attain the desired concentration. This also serves the secondary purpose of heating the work so that less time is required for thorough drying. A flux temperature of about 70°C is recommended. At this temperature, the flux salts are not volatilised and vapour emitted from the surface of the heated flux solution consists entirely of water. Ideally, the flux should contain a wetting agent.

Apart from its role in ensuring that a good quality galvanized coating is formed, a flux solution maintained to recommended standards also enables the galvanizer to increase aluminium additions to the molten zinc. If the quality of flux is poor, typically with a low ammonium chloride content, aluminium levels in excess of 0.003% may result in the presence of small uncoated areas on galvanized components. If the flux solution is maintained at the recommended level of cleanliness and concentration, aluminium additions can be increased to achieve a concentration of 0.005% to 0.007% without any adverse affects.

The benefits derived from higher aluminium additions are not always appreciated. They include; less zinc ash formation, lower iron/zinc alloy layer growth when reactive steels are galvanized and a substantially more attractive coating surface appearance. Aluminium is required to be added to the zinc in small quantities three to four times per production shift. Small ingots containing 20% aluminium and 80% zinc by mass facilitate the rapid dissolution of the aluminium into the molten zinc.

The main components of the flux solution are zinc chloride ($ZnCl_2$) and ammonium chloride (NH_4Cl), but the bath will be contaminated with drag-in of hydrochloric acid (HCl) and iron(II) chloride ($FeCl_2$) from the pickling bath. If the items are rinsed thoroughly between pickling and fluxing the contamination rate is lower than with poor rinsing. Without any rinsing between the pickling bath and the flux bath, the flux will be contaminated very quickly and regular flux purification will be essential.

Chemical composition

A flux solution normally consists of either a double salt or a triple salt. The double salt consists of 2 moles NH_4Cl and 1 mole $ZnCl_2$ (44% NH4Cl). The triple salt has

3 moles NH_4Cl and 1 mole $ZnCl_2$ (54% NH_4Cl). It is also possible to adjust the ratio by adding pure ammonium chloride or zinc chloride. For instance, if we have a high drag-in of zinc chloride from the pickling bath or as a result of neutralising the flux with zinc ash we will have to add relatively more ammonium chloride to maintain the optimum balance.

The typical composition of a well functioning flux bath is:

pH:
3.5 – 4.5 (above pH 5, zinc chloride precipitates out of the solution)

Zinc chloride, $ZnCl_2$:
200 - 300 g/l

Ammonium chloride, NH_4Cl:
200 - 300 g/l

Specific gravity:
1.22 - 1.24 g/ml (26.15 - 28.06 °Be)

Ratio: $ZnCl_2/NH_4Cl$:
46/54

Dissolved iron:
< 2 g/l

Fluxing process

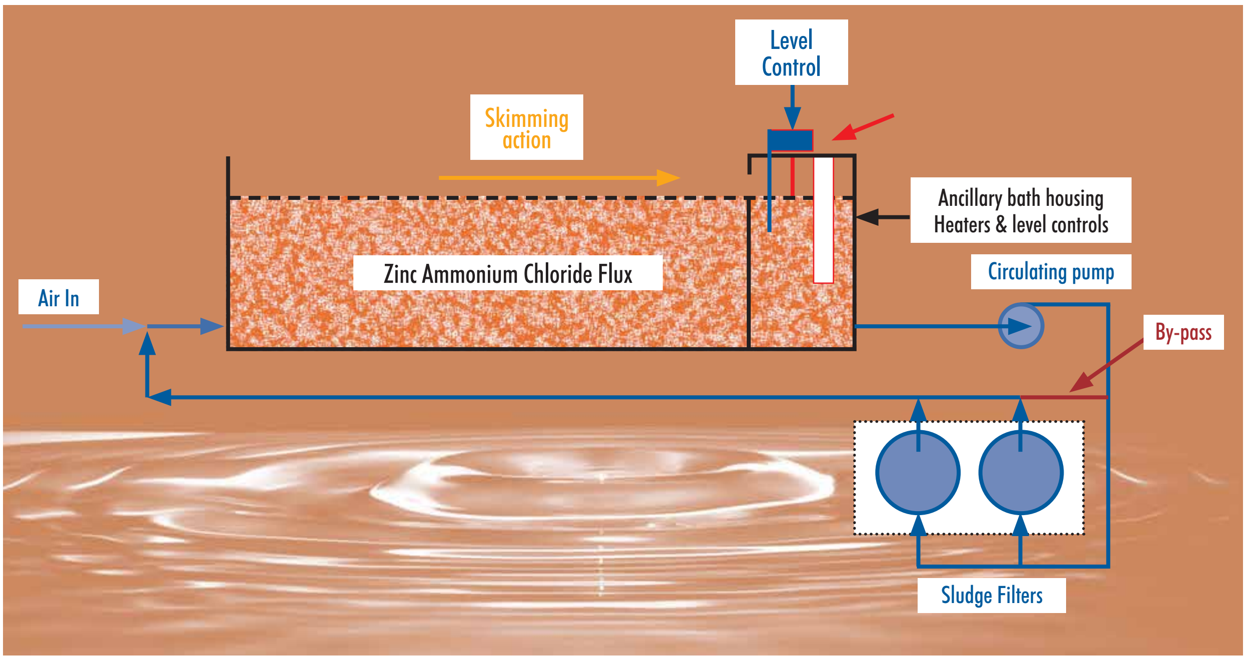
Ammonium chloride is the most reactive component of the flux. It facilitates the reaction between steel surfaces and the molten zinc. The zinc chloride protects the surface from re-oxidation during the period between fluxing and immersion in the molten zinc.

Iron is a contaminant in the flux that will cause dross formation when carried over into the molten zinc (1kg iron will react with 32kg of zinc, generating 33kg of dross). This is one of the main sources of zinc wastage in a galvanizing operation. Iron, which is entrailed in the flux film has the added detrimental effect of reducing efficient run off of excess molten zinc from steel surfaces, during withdrawal from the galvanizing bath.

Content of flux analysis package

The following components can be analysed by the methods presented in this manual:

- pH determination by a pH-meter
- Determination of specific gravity by hydrometer (alternatively by volumetric flask and scales)
- Analysing zinc by titration with EDTA (alternatively using a photometer)
- Analysing ammonia by a colorimetric method on photometer



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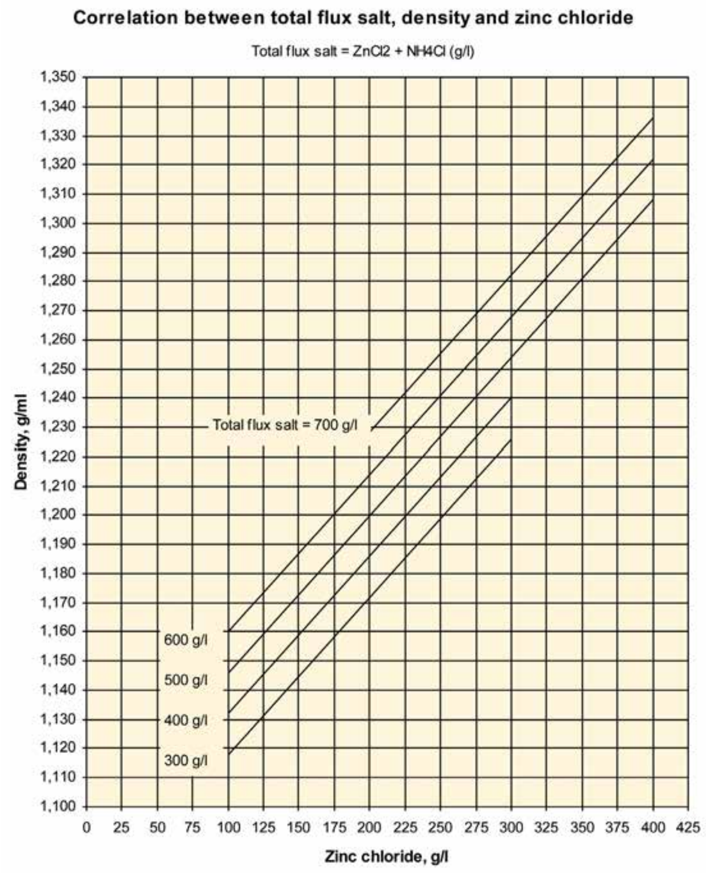

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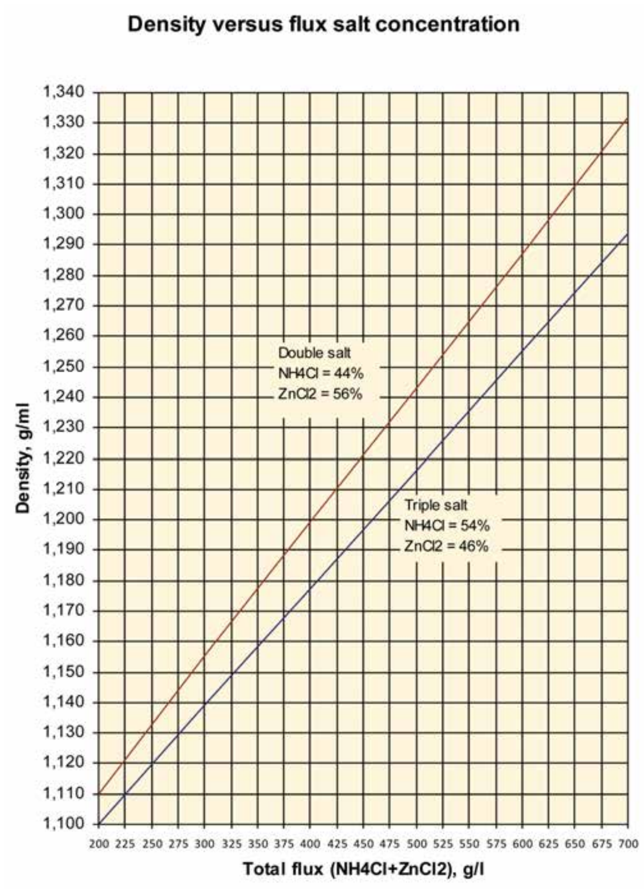


- Determination of dissolved iron(II) by a colorimetric method on a photometer
- Analysing chloride by Mohr titration (to be used as a double check)

The results from the laboratory analyses can be finally calculated by way of a special Excel programme prepared for this application. The calculated results and key figures are transferred to a logbook – a separate sheet in the Excel workbook. The logbook records all analyses data and can be printed as a hard copy for the cabinet file.

The results can also be used in a special flux bath maintenance programme where production data and chemical additions are recorded and used for the calculation of flux bath composition. The programme calculates the estimated composition according to the input data. This will reduce the need for frequent chemical analyses. From time to time, results from chemical analyses are filled into the programme to adjust the composition estimated by the programme. This procedure will reduce the extent of chemical analyses and provide a more comprehensive logbook for flux control – a relevant issue for companies having a quality or environmental management system.

A maintenance programme is not included in the flux analyses package.

Simple flux bath control by density

The density is easy to measure with the aid of a hydrometer or by weighing a fixed volume. The result is in g/ml or °Be. The density has often been used for controlling the composition of the flux

Graph 1: Correlation between total flux salt, density and zinc chloride.

Graph 2: Density versus total flux salt concentration (theoretical).

bath. It is very easy and reliable to use this method in a new flux bath prepared from a double or triple salt, because the density is a well-defined function of the flux salt concentration.

Step by step the composition of the bath changes and after some time the ratio between ammonium chloride and zinc chloride is not the same as in the beginning. It is therefore not correct to use the correlation between flux salt and density that is used for a new bath with no contamination. Other factors will also influence the flux density e.g. hydrochloric acid, dissolved iron and other salts dragged in from the pickling bath and rinse water. In old flux a substantial difference can be expected between the density measured and the actual density or concentration of flux salts. It is important to note that zinc chloride contributes more to the overall density than ammonium chloride, per weight unit.

In *graph 1*, the theoretical co-relation between the density of $ZnCl_2$ and NH_4Cl is depicted. Here, density is a function of $ZNCl_2$ content of flux salts ($ZNCl_2$ + NH_4Cl) as a discrete variable. One of the following equations can be used for calculating one parameter, when the two others are known:

Density in g/ml:
$0.00068 * (ZnCl_2) + 0.00014 * (NH_4Cl) + 1.022 = \text{Density}$

$ZnCl_2$ in g/l:
$1470.6 * \text{Density} - 0.2058 * (NH_4Cl) – 1502,9 = \text{Zinc chloride}$

NH_4Cl in g/l:
$7142.3 * \text{Density} – 4.857 * (ZnCl_2) – 7300 = \text{Ammonium chloride}$

A programme for these calculations is provided in the Excel software included in this package.

Another interesting graph is presented as *graph 2*. Here, density versus total flux salt concentration (=$ZnCl_2$ + NH_4Cl) for both a double salt and a triple salt are depicted. As expected, the graph for the double salt has higher density than for the triple salt for the same flux salt concentration. This is due to the higher zinc chloride concentration in the double salt.

It is important to note that all the graphs and equations in this section are constructed by practical measurements on mixtures of pure zinc chloride and ammonium chloride. Therefore you may expect to find deviations when comparing practical measurements on a flux solution in service, – particularly when the flux is old and contains several contaminants. Therefore you should only use the density graphs and equations as indicative and as a supplement to actual chemical analyses. They can be valuable as a double check on chemical analyses, to avoid significant errors.

ABECO BUILDS ITS biggest tank in Africa

Abeco Tanks is making waves in the African water storage market as they announce having just completed their biggest tank in Africa. The tank - equivalent to two tennis courts in surface area - holds a whopping 5.8 Million litres of water and together with a 3 million litre supplementary tank provides one of South Africa's largest poultry producer's with a total of 8.8 Million litres of saved water.

A water bank is essential if this producer is to continue surviving the almost decade long drought and water insecurity issues in the North West Province of South Africa.

Reliability of water is an especially concerning issue for agriculture as their bottom lines and economic contribution are directly affected and often the first to be hit. The poultry farm for which Abeco built this life saving tank is one of the leading suppliers both nationally and internationally, breeding and raising chickens for processing and distribution on site. Water is not only essential for the survival of livestock but also for the processing plant.

Water security for chickens, especially laying hens, is extremely important as they are highly susceptible to any form of disturbance and can stop laying for up to two weeks because of a single disruptive incident in the water supply.

As Africa's pioneers in water storage solutions, Abeco built the 5.8 Million litre rectangular, sectional bolted tank specifically to cater for the unique requirements of this agricultural giant.

COO of Abeco, Mannie Ramos Jnr comments: "We are the only company in Southern Africa with the expertise to manufacture and install a tank of this size in the rapid timeframe provided. We had to connect the 5.8 Million litre tank with the existing one, ensure it was water-tight, tested and safe, in a record-breaking 38 days versus 128 days – the average time frame."

The rectangular tank's design allowed Abeco to custom create the tank in the most cost-effective way possible. Despite the tank's colossal capacity, the modular design makes tanks of this nature easy to transport and easy to install. Through the marriage between careful design and premium material the tanks are 100% hygienic and safe for livestock consumption and are unaffected by Ultraviolet rays which prevents degradation over time.

They are also built to last using an internal bracing of angle iron welded to base plates, all sealants and rubber components are non-toxic and non-tainting to ensure the purity of the water and all steel components are hot dip galvanized to never rust and use the latest in tank corrosion protection

Storing water for agricultural purposes is not a suggestion in the world of farming. It is a necessity. As water crises have shown us, the need to plan water consumption, track water saving and save for continuity of service is necessary as an effective 'insurance plan' against water interruption brought about by changing weather patterns, exploding populations and urban sprawl.

For more information go to www.abecotanks.co.za or call +27 (0)11 616 7999

BAMR – SERVING THE INDUSTRY for 75 years

BAMR is celebrating its 75th anniversary this year. Fred Duk, a major in the Air Force, returned from the war to establish BAMR on 22 May 1946. Frank, took over in 1961 and Graham Duk, Fred's grandson, became involved in 1998. BAMR remains a customer-focused, family-owned business.

In its early days, the company focused predominantly on instrumentation in the coating industry with the Air Force being the first target focus with Fred's background. To this day, the business remains loyal to its core business principles.

BAMR has been the suppliers and distributors of Elcometer instruments and equipment since 1947. They are the sole official authorised Elcometer distributor and partner in South Africa and most of Africa. The first export sale for Elcometer in 1947 was through BAMR.

BAMR represents some of the market leaders in the world in Southern Africa and strive to combine quality products at competitive prices, with personalised service.

Applications for the Elcometer Protective Coating Inspection range includes any application where you are applying a coating to a substrate including painting a ship, a tank or a structure such as a stadium. Other than measuring the coating thickness, other gauges and applications in this industry include:

- Material thickness
- Surface cleanliness
- Surface profiles
- Climatic conditions including moisture
- Coating thickness – including Wet and Dry Film
- Pinhole and Porosity Testing
- Adhesion Testing

"BAMR is very much a family business. When my brother decided to do his own thing, my wife, Helena stepped in and has been actively involved and instrumental in the marketing side of the business. As the Elcometer business has grown and become more sophisticated, so has our representation of the brand on the African continent" explained Graham, the current owner. "Although a Cape Town based business, we have key account managers in Johannesburg and in KZN and our footprint extends throughout Anglophone and sub-Saharan Africa."

"With our partners on both the supplier front and the distribution front having similar philosophies with regards innovation and customer service, we are very excited about the future of BAMR." says Graham.

For more information about BAMR please feel free to visit our website www.bamr.co.za or contact us by phone or email 021-683-2100 / sales@bamr.co.za

PERSONALITY PROFILE

ANTHONIE DE WIT

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

I have been in the employ of Armco Superlite since April 2000 as a sales engineer for Armco's steel construction products division. Since all these steel products are galvanized, I was taught and had a basic understanding of the technology. In 2012 I was put in charge of the Armco galvanizing operations who soon after that opened its 3rd galvanizing plant in Gauteng. Since then galvanizing has been running in my veins.

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

I studied and met my wife in Pretoria where we settled down and had 2 beautiful children. I love playing golf and cultivating vegetables hydroponically in my greenhouse.

I am passionate about my family friends and work.

What professional achievement are you most proud of?

In my 21 years at Armco there has been many ups and a few downs. If I had to highlight one success story it would definitely be the last 8 year's integration of the German OBO Betterman way of managing a galvanizing business.

Who has had the biggest influence in your life?

My mother who sadly passed away 10 years ago. She grew up poorly, but with full distinctions at school became the first female department head of Afrikaans at a high school in the old Transvaal department of education. She taught me that hard work and persistence will get the job done.

What is your philosophy of life?

We are the masters of our own destiny. Don't just sit around but make your own magic.

What is your favorite reading?

Gary Larson – Far Side of the Moon.

Do you have any dislikes?

People who constantly complain but have no intention to better their situation.

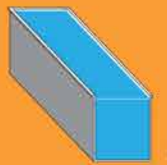
Complete the sentence: "At 5 o'clock on a Friday afternoon... Time to light the braai fire and catch up with my family."

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

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

GALVANIZING BATH SIZES

ISANDO



13m x 1.45m x 2m
(length x width x depth)

RANDFONTEIN

6m x 1.45m x 1.8m
(length x width x depth)

CONSISTENTLY DELIVERING SUPERIOR QUALITY GALVANIZED PRODUCTS TO ALL OUR CUSTOMERS

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

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

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

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

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ARMCO SUPERLITE

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