2005 Volume 2 Issue 1

HOT DIP GALVANIZING TODAY

HOT DIP GALVANIZERS ASSOCIATION Southern Africa

22

Featuring:

Continuous hot dip galvanizing of sheet and wire

Lightweight steel construction in the residential market

Performance of zinc coated fences in the agricultural industry

Storms River Bridge case history

ZINC

steel
SOUTHERN AFRICAN INSTITUTE OF STEEL CONSTRUCTION

The Chromadek Collection

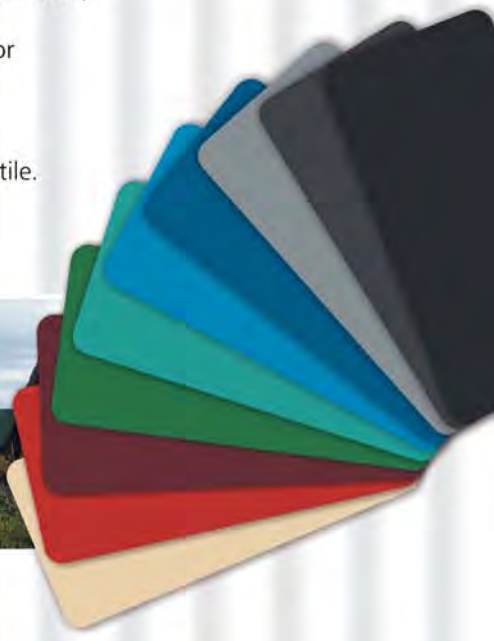
Chromadek®

What is Chromadek®?

Chromadek® is pre-painted, galvanised steel sheet, with guaranteed mechanical properties.
It is available in a wide range of vibrant colours and can be profiled into any roofing profile available on the market.
The zinc coating on the substrate guarantees long term protection against atmospheric corrosion.
Chromadek® is also widely used for gutters, flashings, facias and downpipes, garage doors, louvres and insulated panels, to name but a few applications.
But just what is it that makes Chromadek® the finest of all coated sheet products for the demands of Southern Africa?

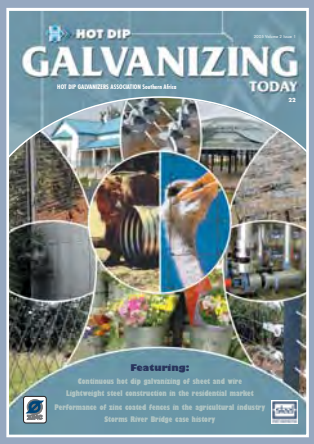
- In our extremes of weather, Chromadek® is durable.
- For innovative architects, it is structurally and visually exciting.
- For almost any kind of construction, or sheet metal end use, it is endlessly versatile.

Chromadek® is produced in South Africa for Southern African conditions using South African experience.



ISPAT ISCOR LIMITED

Chromadek® is available in 13 standard colours, branded at regular intervals - your guarantee that you are using the genuine product backed by the experience of ISPAT ISCOR LIMITED. If you require more information, contact us by e-mail at:chromadek@iscor.com or fax: (016) 889 1041 or call toll free: 0800 005 043



HOT DIP GALVANIZING TODAY

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PLEASE NOTE THAT WE ARE MOVING!

As from 1st April 2005 our new address will be:

Unit U4 (Upper Level), Quality House, St. Christopher Road, St. Andrews, Bedfordview

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May/June: Hot dip galvanized fasteners – process, types and availability

August/September: The world of hot dip galvanizing around us, the annual awards event and the HDGASA celebrates its 40th birthday

November/December: Duplex coatings (hot dip galvanizing plus an appropriate paint)

Hot Dip Galvanizing – Adding value to Steel

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

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Executive Director's Comment

By the time you receive our first magazine for 2005, we shall be well into the new year and implementing our business plans.

We are excited about our plans for the future, including the promotion and further development of Duplex coatings, hot dip galvanized reinforcement in concrete, promotion of heavy duty wire products for fencing and architectural applications to highlight a few examples.

It has been suggested that every 90 seconds, across the world, one ton of steel turns to rust. Another statistic claims that for every two tons of steel produced; one ton is required for the replacement of steel destroyed by corrosion.

So, it is clear that corrosion protection of our steel structures should receive a far higher priority than is currently the position. There are many forms of corrosion protection systems available, many of which have been the result of long term and very costly research and development programmes.

Hot dip galvanizing has been used as a form of barrier protection for about 175 years. Due to the fact that hot dip galvanizing utilizes natural physics of zinc and carbon steel interaction, the process has continued in the forefront of our fight against corrosion of carbon steel.

As an Association of the industry, we provide advice, specifications and technical know how as to appropriate use of hot dip galvanizing and duplex systems in a wide range of environmental conditions.

Note from the Editor

One of the prime objectives of the Hot Dip Galvanizers Association is to market this coating, which we categorically know when appropriately used, provides the user with upwards of 30 years of maintenance free life. Alternatively, where aggressive conditions exist and hot dip galvanizing cannot provide long term protection when used alone, a duplex coating, may be specified. This combination of hot dip galvanizing and an appropriate paint system will provide the user with a synergistic effect, greatly enhancing the performance of the combination of the two systems. (See test results in the previous magazine).

It is for this reason that in order to assess our potential success, we frequently measure the growth of our industry against the current production of hot rolled steel. The total steel produced per year is about four and a half million tons, taken from the SAISI (South African Iron an Steel Institute) web site. Although our measurement method is not very refined and is based on zinc consumption by the general galvanizers (excluding sheet and wire) using an average pickup of 5.5%, we arrive at about 8% of all steelwork that is hot dip galvanized, in South Africa.

Being a supporter of the SAISC I had the privilege of meeting John Cross the Vice President of the American Institute of Steel Construction (AISC). John believed that to successfully market a product or commodity relating examples of successful uses of that product or commodity, played a major role.

One such example is the selection of the coating for a PGM project in Rustenburg, that was built some seven years ago. The client, due to their successful use of protecting steel underground by hot dip galvanizing, decided to entertain its use above ground on some 6500 tons of superstructure steelwork. The comparable specification was blast clean to SA2½, followed up by three coats of vinyl co-polymer paint. The initial difference in cost amounted to a savings of about R10million. Because hot dip galvanizing is generally predictable in terms of its life, the client felt quite sure that he would achieve at least 25 years of life before maintenance and if he did, he would save about R55 million at that days cost. After five years we conducted a coating performance survey and found that based on the coating's corrosion rate, a term of at least 40 years was easily achievable. So the savings of R55 million pales in insignificance by comparison.

In this issue we look at the performance of hot dip galvanizing used to protect the steelwork for the widening of the Storms River Bridge, done in 1986. After 18 years the coating is performing extremely well and it is anticipated that it will last conservatively a further 30 to 40 years, maintenance free!

Having visited many specifiers over the past few years, I notice a willingness to include hot dip galvanizing of lipped channel purlins and sheeting rails. Obviously, this is because it is difficult to successfully paint on the inside lips of the purlins and difficult to conduct a successful coating inspection.

However, in spite of all the advantages of hot dip galvanizing, it remains puzzling why steel columns and frames for most buildings situated in corrosion categories C1 to C3 are generally only painted.

This issue further looks at continuous hot dip galvanizing of sheet and wire and some of their respective uses. The atmospheric corrosion performance of various materials and coated wire is also included. We have also highlighted future features for 2005 so that anyone wishing to participate may do so.

The HDGASA is passionate about the industry it serves and will as far as possible act in an unbiased manner when called to offer an opinion to customers and members of this organisation. We welcome any comments or suggestions in this regard.

HOT DIP GALVANIZING OF SHEET METAL

Hot Dip Galvanizing of Sheet Metal

Hot dip galvanized sheet is produced on continuous zinc coating lines, (figure 1), from either cold rolled (thickness range 0.35 to <1.6mm) or hot rolled (thickness range 1.6 to 3.0mm) steel coil to the requirements of **ASTM A653, SANS 4998** or **SANS 3575**.

The coils are welded end on end to form a continuous strip. After degreasing the strip is pickled or oxidized. Oxides are then removed from the surfaces by reduction at 950°C. At the same time the strip is soft-annealed. The surfaces of the strip, now chemically clean, are moved through a protective gas atmosphere and directly down into the zinc bath.

The strip is withdrawn from the bath vertically and passed through "air knives". Controlled jets of air or steam are blown through the knives, wiping the zinc coating to the desired thickness.

The galvanizing process yields an even zinc coated sheet with a bright smooth metallic finish. The zinc coating can be supplied with a regular or flattened minimised spangle finish. Different to general hot dip galvanizing, where a greater portion of the coating consists of iron/zinc alloys, continuous galvanized sheeting because of its requirement for ductility has very little iron/zinc alloy formation (1 to 2µm), with the rest of the coating being pure zinc.

After cooling, straightening and treatment against wet storage stain, the strip is cut into suitably sized sheets or rolled into coils for delivery or subsequent painting and/or profiling (figure 1).

Zinc coating surface finish

The following surface finishes may be ordered to suit specific end-use requirements:

Regular spangle (also known as normal spangle.

This is the unaltered, multifaceted crystal structure that occurs during normal solidification of a hot dip zinc coating on a steel sheet.

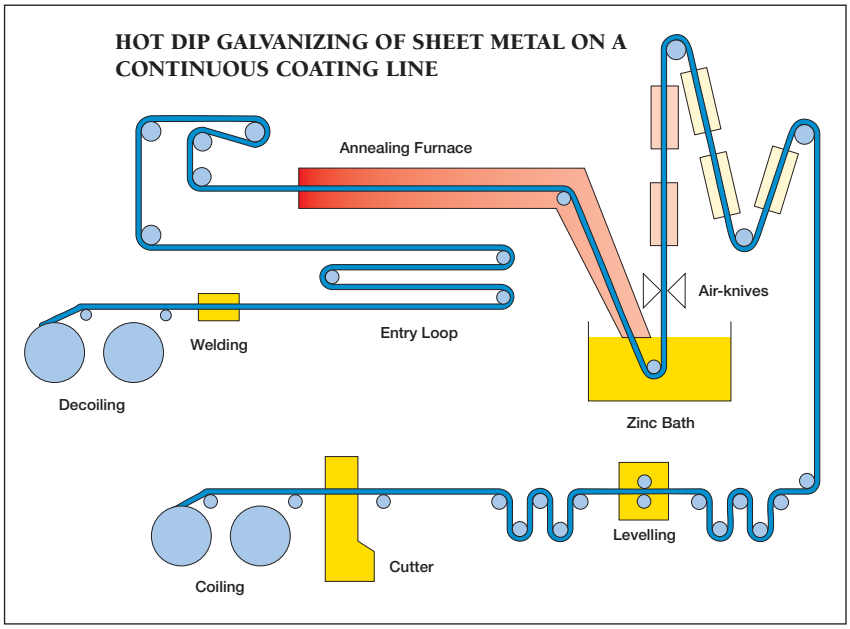

Figure 1. Schematic diagram showing the continuous hot dip galvanizing process for the coating of sheet.

Variations in the size and brightness of the spangles are possible, depending on the galvanizing process and conditions, but this has no effect on the quality and corrosion resistance of the coating. Regular spangle is supplied for a wide range of applications where overpainting for maintenance purposes can be undertaken at a later stage.

Flattened minimised spangle

This is a zinc coating that is obtained by restricting the normal zinc crystal growth followed by the application of a skin pass process. The zinc coating thus obtained has improved formability and the zinc surface serves as an excellent base for pre-painting, post-painting and powder coating applications.

This finish is recommended for applications where a high gloss paint finish is required. It is available for zinc coatings of mass up to Z275, and a maximum steel thickness of 1.20mm if passivation is required, or a maximum steel thickness of 1.60mm if passivation is not required.

Zinc coatings of different thicknesses in accordance with **SANS 4998** or **SANS 3575** may be ordered to suit specific end use requirements. Certain coating grades are more readily available (tables 1 and 2 respectively).

The thickness and type of steel substrate is selected on the grounds of mechanical and structural consideration, whereas the thickness of the zinc coating is selected according to the corrosion-resistant life expectancy required.

Corrosion resistance

The protection afforded by a hot dip galvanized coating under normal conditions of exposure is directly related to its thickness. The coating on sheet, normally stocked by retailers, is Z 275, which is suitable for a mild environment.

It is recommended that galvanized sheeting be overpainted timeously, preferably before the first appearance of red corrosion products. Where conditions require greater corrosion protection, a thicker class of coating ie. Z 600 or the addition of a paint coating should be considered (Z600 class of coating is now more readily available). In the case of the heavier coating, the sheet is not suitable for severe forming other than normal corrugating or curving.

Bend tests to evaluate the adhesion of the zinc coating are carried out and evaluated in accordance with relevant specifications (table 3). In addition to this, impact adherence cupping tests are performed on all products, irrespective of specification, to ensure good adhesion of the zinc coating.

Wet storage stain (white rust)

When galvanized sheet in coil or sheet packs is stored under wet conditions, the galvanizing may be damaged by wet storage staining.

Rainwater or water vapour can easily be drawn in between tightly profiled or flat sheets, or between laps of coils by capillary action. Due to the absence of freely circulating air, this moisture cannot evaporate, causing unfavourable conditions that may result in white rust on galvanized sheeting.

Normally, light white staining on galvanized sheet is not serious. The wet storage corrosion process will stop when the affected areas are dried and exposed to the atmosphere. The discoloration will disappear within a few months during the normal weathering of the material. Where affected surfaces will form part of unexposed overlaps or other concealed areas that may be subject to extended periods of dampness, such areas should be cleaned and additionally protected.

Galvanized material must under no circumstances be stacked directly on a floor. See figures 4, 5 and 6, table 4 and also Removal of Wet Storage Stain.

Surface treatment

The following surface treatments are normally used to reduce the possibility of wet storage stain during transport and storage:

Passivation

Passivation by potassium dichromate is normally applied to all galvanized material. In cases where this treatment may interfere with subsequent processing, the galvanized steel may be ordered without passivation, in which case oiling of the zinc surface is recommended.

Oiling

A special corrosion-preventive oil is used to coat galvanized sheet as an additional protection against wet storage staining during handling and storage. Oil is only used if requested.

If unoiled unpassivated galvanized steel sheet is ordered, proper protective packing should be requested to protect the material against the ingress of moisture during transport and storage. (Refer to Safe Storage).

Cut edge corrosion resistance

The introduction of continuously galvanized coil that is subsequently cut into sheet lengths, has tended to focus attention on the behaviour of cut edges which are exposed to atmospheric corrosion. Sheet, thinner than 1.6mm is usually adequately protected at cut edges by the cathodic action of the zinc coating. Similarly, side trimmed edges seldom present a corrosion problem.

Thicker coatings provide superior cathodic protection.

ZINC COATING MASS IN ACCORDANCE WITH SABS ISO 4998 AND 3575				
Coating Designation	Mass of coatings * (both sides inclusive) g/m², min.		Equivalent thickness per side * * µm, min	
	Average	Individual	Average	Individual
Z 100†	100	85	7	6 (4,8)
Z 180†	180	150	13	11 (8.5)
Z 200†	200	170	14	12 (9,7)
Z 275	275	235	20	17 (13,4)
Z 350	350	300	25	21 (17,1)
Z 450	450	385	32	28 (22)
Z 600	600	510	43	36 (29)
Z 700	700	595	50	43 (34)

Table 1. Mass per unit area of zinc coating.

Coating Designation	Mass of coatings * (both sides inclusive) g/m², min.		Equivalent thickness per side * * µm, min	
	Average	Individual	Average	Individual
Z160[1,2] †	160	135	11	9 (7.7)
Z275	275	235	20	17 (13.4)
Z600[3,4,5]	600	510	43	36 (29)

Table 2. Readily available zinc coating grades in Southern Africa.

NOTES

* Not less than 40% of the individual value should normally be found on each surface, indicated in brackets.

† Although coating Classes Z 100, Z160, Z 180 and Z 200 are included in this table, these classes are not recommended for bare external applications but have been included for products which would subsequently be further protected by suitable paint systems.

* * For information only. The equivalent thickness is calculated from the following formula:

$$\text{Thickness; } \mu m = \frac{\text{Mass per unit area, g/m}^2}{2 \times 7}$$

(7 is the approximate specific gravity of zinc)

The letter Z in the coating designation indicates a pure zinc coating and the number denotes the total mass of the coating on both faces of the sheet (g/m²)

1. Only available on 0.35mm full-hard material
2. Iscor specification only
3. Not recommended for forming grades
4. Not available on full hard material
5. Stock available from some suppliers

Coating Designation	Commercial Steel (CS), Forming Steel (FS) and Deep Drawing Steel (DDS) ASTM A653M-97			Structural Steel (SS) ASTM A653M-97●		
	Galvanized Sheet Thickness t(mm)			Grade 230	Grade 255	Grade 275
	0.4 ≤ t ≤ 1.0	1.0 < t ≤ 2.0	t > 2			
Z275	0	0	1	1.5	2	2.5
Z600	2	2	2	2	2	2.5
● **Note:** Grades 340 and 550 do not have specified requirements for this property						

Table 3. Ratio of the inside bend diameter to the thickness of the specimen

Strain ageing

Galvanized steel sheet tends to strain age and this may lead to the following:

1. Surface markings from stretcher strain (Lüder's lines) or fluting when the sheet is formed.
2. Deterioration in ductility.

It is recommended that the period between final processing at the mill and fabrication be kept as short as possible, preferably not exceeding six weeks.

Painting

Chemical conversion coatings and primers have been developed to provide good adhesion of subsequent paint films on zinc coated surfaces. To obtain optimum results it is essential to adhere to the instructions of the paint manufacturers. (Contact the HDGASA for further information).

Primer coated galvanized steel sheet produced in a continuous coating line (Chromaprep®)

Coating process

Chromaprep® is a registered trade name for cold rolled or hot dip galvanized steel sheet, coated with a high quality, flexible and corrosion inhibiting epoxy primer. The substrate is chemically cleaned and treated to ensure good adhesion of the chromate-rich epoxy based primer.

The coating has a nominal thickness of 4-6 micrometres applied by a sophisticated continuous roller coating process, permitting control of coating uniformity and film thickness within narrow limits. The primer coat is finally oven cured and is suitable for overcoating with most locally available finishing paint systems. (Refer to table 5).

Chromaprep® is supplied with an epoxy primer coating on both sides of the steel sheet. Chromaprep® with a cold rolled steel substrate may be used for indoor applicaµtions while

EVALUATION OF WET STORAGE STAIN		
VISIBLE EFFECT	**CAUSE**	**REMEDIAL ACTION**
LIGHT WHITE DISCOLOURATION - THIN, WHITE POWDERY DEPOSIT	Caused by moisture trapped between sheets or components during transportation or storage, or by condensation in the absence of adequate ventilation.	None required. The protective properties of zinc are not impaired by the presence of superficial white discolouration. Existing white discolouration deposits will slowly convert to protective basic zinc carbonate. Not suitable for post painting before removing loosely adhering deposits.
HEAVY WHITE DISCOLOURATION- THICK, CRUSTY DEPOSITS	Prolonged adverse storage or inadequate protection during transport, allowing considerable water ingress between closely stacked sheets or components.	Before painting, remove all traces of loosely adhering deposits with stiff bristle brush (not a wire brush). Check residual zinc coating thickness with an electromagnetic thickness gauge. (The electromagnetic thickness gauge is used merely as an indicator of the approximate zinc coating thickness on sheeting. The method cannot be used to fail the coating in terms of thickness.) If the coating thickness is within specification and if the sheet or component is to be used in reasonably dry or freely exposed conditions, no action is required.
BLACK STAINING AND WHITE DISCOLOURATION WITH POWDERY DEPOSITS	Usually very early stage of superficial zinc corrosion normally due to the formation of complex surface zinc corrosion product. Black staining does not imply that the zinc coating has been destroyed.	Check zinc coating thickness using an electromagnetic thickness gauge. (The electromagnetic thickness gauge is used merely as an indicator of the approximate zinc coating thickness on sheeting. The method cannot be used to fail the coating in terms of thickness.) If in doubt contact the HDGASA before painting, due to the complex nature of stains.
RED RUST	Corrosion of steel substrate where zinc coating has broken down completely. Should not be confused with superficial staining.	In general, sheet or components showing red rust should be repaired or not used at all.

Table 4. Evaluation of wet storage stain.

Chromaprep® with a hot dip galvanized substrate is usually intended for exterior use, after application of the desired final coating system.

Typical primer coat properties

Dry film thickness	4-6 micrometres
Heat resistance	Max 120°C
Resistance to common water based detergents	Excellent
Resistance to mild solvents(1)	Fair
Flexibility(2)	1T
UV - resistance(3)	Fair

(1) Sensitive to common lacquer thinners, i.e. chlorinated or aromatic hydro-carbons and ketones but resistant to mineral turpentine, solvent naphta, methylated spirits and paraffins.
(2) No coating failure or loss of adhesion when bent around a mandrel with a diameter as indicated (T is the thickness of the sheet in mm)
(3) As is the case with most epoxy primer coatings, CHROMAPREP® is sensitive to ultra-violet radiation and should not be exposed to direct sunlight for prolonged periods before application of the final coating system. When directly exposed to sun-light (ultra-violet radiation) the final coat must be applied within seven days of being exposed.

Table 5.

Corrosion resistance

Chromaprep® serves as a good corrosion inhibiting primer coat for subsequent painting. Resistance to corrosion creep is improved by using a galvanized steel substrate, which is strongly recommended for exterior applications.

Cleaning of primer coat before final painting

Surfaces should be cleaned by removing surface contaminants by wiping with natural mineral turpentine, solvent naphta or methylated spirits, followed by a warm water detergent wash and a clean water rinse. Users are advised to ensure that thinners or adhesives used, are compatible with Chromaprep®. The Chromaprep® primer coat is slightly undercured to ensure good bonding of subsequent top coats. The liberal use of strong solvents can and will detach the primer coat, which may lead to premature peeling of the paint.

Common lacquer thinners such as chlorinated hydrocarbons or ketones (MEK) should not be used for cleaning purposes as these may affect the adhesion of the epoxy primer-coat.

Application of paint coatings

The required paint finish can be applied by normal spray, airless spray or brushing techniques. Usually an additional primer coat will not be necessary, but for most paints a better bond between the Chromaprep® surface and the top coat, as well as a higher quality paint surface, may be obtained by application of a primer or intermediate coat for the selected paint systems.

PROPERTY	TEST CONDITIONS	METHOD	SPECIFICATION	TYPICAL
Resistance to colour change	QUV (1000 hours)	ASTM G53		ΔE<5, e.g. Gemsbok Sand
Resistance to chalking	QUV (1000 hours)	ASTM G53 ASTM D659		Rating Range: 1-2
Resistance to corrosion: - Edge creep - Blister size	Salt spray (1000 hours) After 1000 hours After 1000 hours	ASTM B117 ASTM A654 ASTM D714	 ≤ 3mm ≤ 8F	 < 2mm < 8F
Flexibility: bend test		ASTM D4145	3T. No adhesion loss	2T. No adhesion loss
Flexibility: reverse impact		ASTM D2794	No cracks No adhesion loss	No cracks No adhesion loss
Film hardness		ASTM D3363	F - H	F - H
Dry film thickness		NCCA 4.2.2	22µm minimum inclusive of primer	22µm minimum inclusive of primer
Gloss at 60°	At time of coating	ASTM D523	25 - 35%	25 - 35%

Table 6. CHROMADEK® paint system properties.

Amongst current industrial products, the following paint systems can be applied to Chromaprep®: alkyds, vinyls, acrylics, polyesters, powdercoatings, stoving enamels, epoxies and poly-urethanes.

Painted cold rolled galvanized steel sheet produced in a continuous coating line (CHROMADEK® or CHROMADEK® PLUS)

CHROMADEK® is the trade name for this pre-painted galvanized steel sheet. CHROMADEK® is a colour coat comprising a Z275 hot dip galvanized substrate, pre-primed on both surfaces with a 4 to 6 micron DFT primer.

CHROMADEK® paint is then applied to both surfaces, a 20 micron DFT to one surface and about 8 micron DFT to the opposite surface (figure 3).

The colour coated products are coated on a sophisticated continuous roller coating line. The modern coating process permits good control of the important painting parameters and rigid quality control on each finished coil ensures that every batch conforms to specification. Excellent paint adhesion is achieved and corrosion resistance enhanced by careful preparation of the steel sheet under factory conditions prior to paint application. The paint systems are oven cured. The aesthetic appearance and durability of CHROMADEK® cannot easily be achieved by conventional hand painted systems.

The coating is highly formable and provides additional protection under conditions where the corrosion resistance of unpainted galvanized sheeting may prove inadequate.

Corrosion resistance

CHROMADEK® is intended for exposure to rural, mildly chemically polluted or moderate marine conditions. Best results can be obtained through the correct application, good workmanship and maintenance procedures.

NOTE: CHROMADEK® ***is not recommended for application in marine environments (area approximately 1km from the sea) or exposure to industrial environments where there is an accumulation of strong acid vapours.*** **CHROMADEK® PLUS** ***is recommended for these conditions.***

CHROMADEK® PLUS is a colour coat comprising a Z275 hot dip galvanized steel substrate, pre-primed on one or both surfaces with 20 - 25 micron DFT chrome free universal primer. Alternatively, only one surface is coated in accordance with the above and the other surface as per the standard CHROMADEK® (4 - 6 micron DFT). CHROMADEK® paint is then applied to both surfaces, both to 20 micron DFT (figure 3).

The Plus system has excellent physical properties, excellent flexibility, excellent corrosion resistance with excellent resistance to ultraviolet radiation (UV performance).

Corrosion resistance

CHROMADEK® Plus is recommended for exterior building profiles in applications requiring high formability, good gloss retention, high colour stability and excellent corrosion resistance. It is suitable for corrosive environments such as industrial and marine environments. Marine environments can generally be defined as areas within 1km of the sea (table 6).

Fastening methods

Mechanical fastening systems such as rivets, self-tapping screws, bolts and nuts, spring clips and wire staples can be used, as well as various seaming methods including lock- and box seaming.

Where protection is needed, fasteners should, where possible, be:

- hot dip galvanized; or
- manufactured from a corrosion resistant material; or
- electroplated and overcoated with a suitable top coat.

Figure 2. S-Rib galvanized steel sheeting – Z600 coating classification used for architectural applications.

Cutting, touch-up and maintenance

Abrasive cutting or trimming of CHROMADEK® sheeting on roof tops should be avoided. Should cutting be

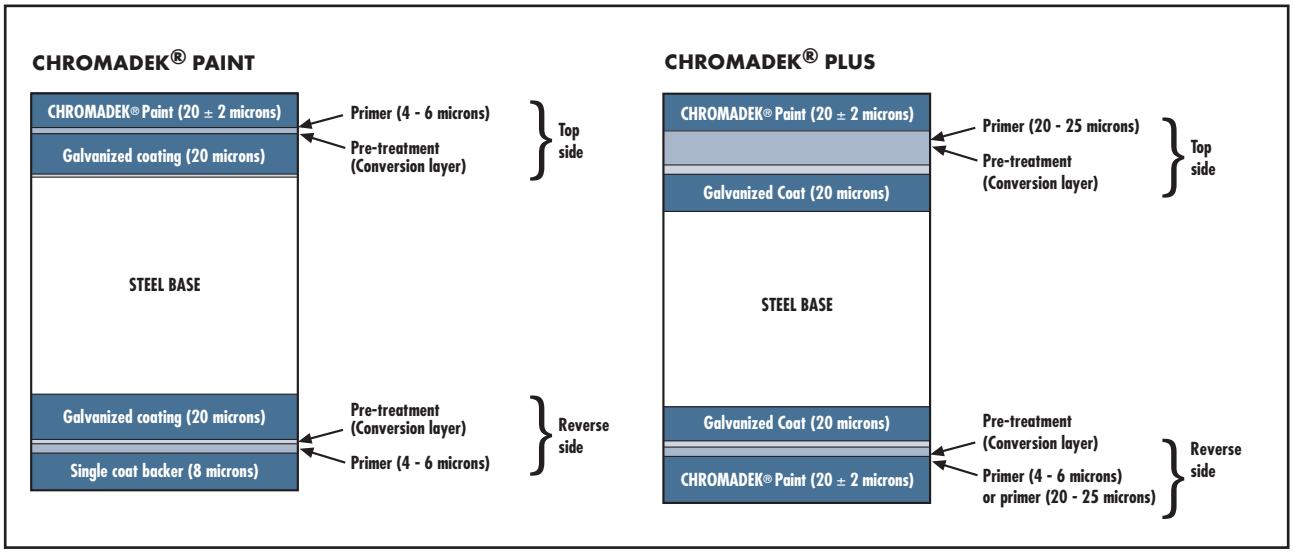

Figure 3.

necessary, remove all iron particles by vigorous brushing with a broom or bristle brush after cutting, to avoid tarnishing the CHROMADEK® paint surface.

In order to site cut a sheet with clean edges and no paint damage, a sheet nibbler is recommended.

Specially formulated air-drying touch-up paints are available. Care should be exercised to minimise overpainting as this might accentuate the defect. The ultra-violet resistance of air-drying touch-up paints is generally less than the oven-cured CHROMADEK® finishes. Accordingly, touching-up of scratches should be done with a thin paint brush to minimise unnecessary overpainting. If aesthetically acceptable, it is recommended that minor scratches resulting from erection and rough handling be left uncoated as the galvanized substrate will offer adequate sacrificial protection against corrosion.

The life of a CHROMADEK® painted surface can be extended and the appearance maintained by washing down periodically with water and a mild detergent to prevent any build-up of corrosive deposits, especially in marine or industrially polluted environments.

The extent of the damage to CHROMADEK® paint coatings is rather difficult to assess. In cases where the original gloss and colour have been retained, there should be no cause for concern. On proper drying of the moisture contained between closely nestled sheets, no further deterioration will occur. Where discolouration and/or signs of white corrosion products (except cut edges) are evident, such sheets should be substituted with new material.

Certain situations can create unusually aggressive conditions for the exposed, reverse sides of roof sheets. These include coastal locations (and therefore the risk of saline spray and deposits collecting on the exposed reverse sides of overhangs), extremely polluted industrial environments, and very low pitched roofs. In these or similar conditions, extra protection may be necessary. This can be achieved by specifying CHROMADEK® PLUS to both surfaces.

Compatibility

Most materials used in contact with traditional galvanized steel can be safely used with CHROMADEK®. Run-off water from Cor-Ten, lead or copper products, however, may cause staining and should not be allowed to come into contact with the painted surface.

Edge protection

Generally cut edges on CHROMADEK® sheets do not present a corrosion problem even in coastal areas as the galvanized coating will sacrificially protect the exposed steel. Small traces of white deposits on cut edges should therefore, not be a reason for concern.

The handling and protection of galvanized and prepainted steel sheet during storage

Galvanized and prepainted galvanized sheet is known to perform exceptionally well when exposed to the elements. Under normal wet-and-dry conditions, e.g. when galvanized sheet is used as roofing and for cladding of buildings, a protective zinc oxide/zinc carbonate layer naturally forms on the exposed surfaces of the material, which improves the resistance against corrosion. In the case of pre-painted sheeting, the protective paint coating offers an additional physical barrier against the elements.

However, the protective nature of these coatings may be seriously impaired when exposed to wet conditions for extended periods in the absence of air. The material is at its most vulnerable during prolonged storage without the necessary precautions.

Rain water or water vapour can easily be drawn in between tightly nested profiled or flat sheets, or

between laps of coils, by capillary action (figure 4).

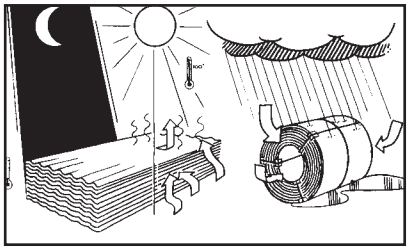

Figure 4.

Due to the absence of freely circulating air, this moisture cannot evaporate, causing unfavourable conditions which may result in wet storage stain, often referred to as "white rust" on galvanized sheeting. See Evaluation of Wet Storage Stain – table 4. In the case of prepainted sheeting these conditions may cause discolouration of the paint film and in extreme cases wet storage staining, similar to galvanized sheeting.

Wet storage stain may start soon after nested packs or coils of sheet are exposed to wet conditions and may affect the expected maintenance-free life of the sheeting unless arrested at an early stage. The material has to be thoroughly dried and exposed to freely circulating air to stop this corrosion process (figure 5).

Steps taken to protect galvanized sheet against damage by wet storage stain

It is standard practice to passivate the surfaces of galvanized sheet by chemical treatment during processing, in order to inhibit the occurrence of wet storage stain. Furthermore, galvanized sheet can be ordered with a special protective oil, which is supplementary to the normal passivation and is intended to provide additional protection during handling and storage.

In spite of these precautions, galvanized sheet cannot be entirely safeguarded against wet storage stain, especially when stored incorrectly under adverse conditions.

A special type of packaging is provided for flat sheets and coils. Users, who do not have the necessary facilities to temporarily prevent the ingress of moisture are advised to specify such protective packaging.

Every endeavour is taken by manufacturers to ensure that coated sheet products leave the works dry and in prime condition. Such products, whether de-spatched in coils or cut lengths, are packed, handled and loaded, under cover, onto vehicles where they are covered with tarpaulins or canopies.

Safe storage

To prevent unnecessary damage to galvanized or colour-coated sheets,

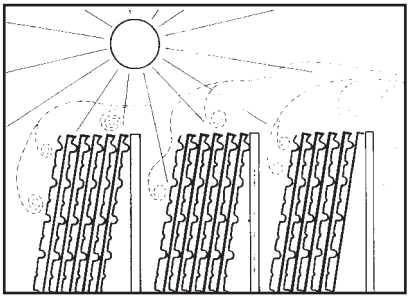

Figure 5.

proper measures should be taken to prevent contamination by moisture while the material is still bundled or nested in stacks (figure 5).

If not required for immediate use, coils or packs of sheets must be stacked on site under properly designed cover, clear off the ground and protected from wind-driven rain (figure 6).

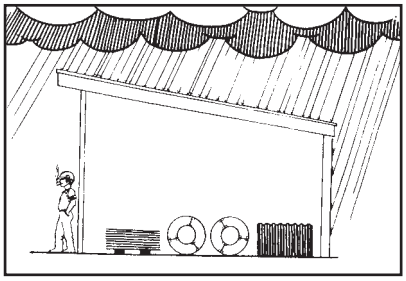

Figure 6.

Plastic tarpaulins which completely envelop packs of sheets or coils should not be used, as a sudden drop in ambient temperature may cause condensation of water vapour, which can easily be drawn in between nested sheeting by capillary action.

Ideally, deliveries of galvanized and colour-coated steel sheet to the building site should be scheduled for a storage period of not longer than two weeks prior to installation. Inspect the storage site regularly to ensure that moisture does not penetrate the stock.

Removal of Wet Storage Stain

Wet storage stain should rather be prevented than cured.

Although in extreme cases the protective value of the coating may be impaired, wet storage stain attack is often superficial despite the relative bulkiness of the corrosion product. Where surface staining is light and smooth without growth of the zinc oxide layer as judged by lightly rubbing fingertips across the surface, the staining will gradually disappear and blend in with the surrounding zinc surface as a result of normal weathering in service.

When the affected area will not be fully exposed in service or when it will be subjected to a humid environment, wet storage staining must be removed, even if it is superficial. This is essential for the basic zinc carbonate film to form. The formation of this zinc carbonate film is necessary to ensure long term service life.

Light deposits can be removed by cleaning with a stiff bristle (not wire) brush. Heavier deposits can be removed by brushing with a 5% solution of sodium or potassium dichromate with the addition of 0.1% by volume of concentrated sulphuric acid. Alternatively, a 10% solution of acetic acid can be used. These solutions are applied with a stiff brush and left for about 30 seconds before thoroughly rinsing and drying.

Unless present prior to shipment from the galvanizer, the development of wet storage stain is not the responsibility of the galvanizer. The customer must exercise proper caution during transportation and storage to protect against wet storage staining.

Branding

All hot dip galvanized and CHROMADEK® strip produced by Ispat Iscor is marked every metre with information regarding the material origin, date of manufacture and dimensions. Coating mass is also provided (see table 2 for the conversion from mass to coating thickness).

Because of the reputation of Ispat Iscor' galvanized and CHROMADEK® sheeting in the South African market, both names are now used generically to describe other metallic and colour coated roof sheeting, although they are not necessarily the same. It is thus important to establish with certainty the quality and relevent specification of the product at procurement stage.

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Lightweight steel construction in the residential market

Broadly speaking, traditionally there have been two technologies used for residential architecture, worldwide. One is traditional masonry, and the other is lightweight construction with predominantly timber or timber products.

Each of these technologies has evolved over thousands of years, influenced by climate, culture, and the technological advances and experience of the society that utilizes it.

This evolution has been accelerated by globalisation, bringing greater speeds of communication and increased movement of materials around the world. Universal trends in residential building construction now show a movement towards lightweight and modular construction, and in particular, lightweight steel.

Typical construction joint.

General description of lightweight steel construction

The main element of lightweight steel construction is a light gauge steel-framing member, made from structural quality sheet steel that is usually formed by cold rolling through dies. As implied, this production method does not involve heat input and its associated expense. Elements are thinner, production rate faster, and the finish is smoother. All these factors add up to lower production costs when compared with equivalent, but heavier hot rolled steel products such as I-beams or channels.

The wall and roof structure of a house would be built with these lightweight sections onto a floor slab. Cladding of the roof would follow, providing a protected area for installing services and cladding the walls, typically with gypsum sheet. Wall exterior would then be constructed on the outside, materials being of a wide choice, examples being brick skin, fibre cement, timber, or metal sheet, as are the possibilities in the case of equivalent timber frame constructions.

A light weight steel framed house, before cladding.

There are two basic approaches to the construction of a steel frame:

- The American system has evolved directly from the popular 4"x2" timber frame method. Standard steel sections are commonly available to homebuilders, who can cut and assemble them on site to complete the steel frame required.
- The Australians, in contrast, submit their house plan to a framing company, who designs the framing system and manufactures all the structural components at their factory. The materials are then brought to site as a kit for assembly. This method has the advantage of superior quality control that can be offered by an experienced, clean and fully equipped professional fabricator, compared with the sometimes less-than-perfect resources, including wrong tools and poor workmanship that might prevail on a building site. Less steel is also used; as there are no off-cuts or wastage at the site for the client's account. This would appear to be the preferable alternative for South Africa, at least until local expertise has grown to a point where both methods could be competitive.

Benefits and Challenges of Lightweight vs. Conventional Masonry Construction

Benefits:

- Speed of erection
- Dimensional Accuracy (straight and erect walls with 90 degree corners),
- Predictability of end – product cost, quality, delivery appearance.
- An advantage for sites with problem soil conditions, remote sites or steep sites.
- Environmentally and economically advantageous, as steel is fully recoverable and recyclable. Lightweight homes are easy to modify, add to, or demolish, with minimal site impact.
- More stable than timber as a framing element and is resistant to cracking, rot, termites, and warping.

Inspecting stock steel coil strips to be used for subsequent profiling of light weight steel frames in Australia.

- Continuous hot dip galvanized sheet steel affords excellent corrosion resistance.

Challenges:

In comparison with America or Australia, South Africa has a limited history of lightweight home construction. Locally grown construction timber tends to be of comparatively poor quality. Together with limited availability and expense, this has made masonry construction a first preference. Major investment in the education of the industry in the use of this new technology will be necessary. This task should not be underestimated, as conservatism

Once the roof is completed, the non-conventional light weight steel framed building starts looking like a conventional South African home.

resists change, especially when there is the perception that current building methods are as good as anyone needs.

- General perceptions relate lightweight construction to temporary structures such as site offices and temporary accommodation.
- Accreditation: Local Authorities are not familiar with the technology. There will be delays and disputes during the process of drafting new building regulations and agrément certificates
- Established contractors and suppliers (bricks, sand, cement) to the traditional building sectors may see the new technology as a threat to their business.
- Builders have to familiarize themselves with new methods.

Cost comparison

A very basic comparison of costs was done by the South African Institute of Steel Construction (SAISC) on a conventional and lightweight steel frame house of 200m^2 floor area, and identical plan.

Cost per unit area in the case of the lightweight steel structure was about 3-5% less. This saving could be more in practice, where the house structure, in the case of the lightweight method, would be altered specifically to exploit all the cost advantages that this technology can offer. Put another way, lightweight constructions cannot be optimized using a "brick and mortar" approach to design.

Time is saved in installing services. (Water and electrical reticulation) Chasing grooves and breaking holes in masonry walls, as well as replastering, are eliminated.

Not accounted for is the speed of construction, cutting labour cost, to the benefit of the developer, contractor and the homeowner.

The way forward

New technologies often begin by mimicking the older more trusted methods. As Ancient Greek Stone temples were built according to the known timber post and lintel system, with stone arch and vault structures evolving later, so many lightweight steel framed construction buildings are designed to look like standard masonry construction.

We have already seen exciting new developments in countries that are familiar and comfortable with lightweight technology e.g. USA, Europe and Australia. Lightweight construction offers so many new ways of building, with more versatile options for design. The reduced mass of walls and roofs gives this flexibility. Cladding comes in wide and exciting ranges, an example being a durable terra cotta panel finish. Modular construction can also improve the form of buildings, where crafted, well-detailed units are assembled on site. Multi-storey structures can also exploit all these advantages.

Once the industry has become acquainted with this new technology, we can hopefully look forward to it growing in favour, to the benefit of our local architecture, as has been happening in Australia and elsewhere abroad.

Acknowledgement and thanks are due to Sue Clark of Equilibrium Studio (Pty) Ltd and Dr. Hennie de Clercq of SAISC for information contained in this article.

Light weight framed structures have many advantages.

Relatively sophisticated joints can be overcome by incorporating heavier guage steel, hot dip galvanized for corrosion protection.

Corrugated iron has stood the test of time...

The term "corrugated iron" often conjures up a picture of a rather unattractive building material, used in out of the way places by people who were constructing houses and other buildings on the cheap. But when people start to think further, they realise that in fact this is an exceptional product that helped to shape the pioneering history of many parts of the world.

In fact once you delve deeper, many of us remember with nostalgia the houses we grew up in, where the sound of the falling rain could be heard drumming on the roof, or the deafening sound of hail stones pounding down on the corrugated iron roof drowned out all chances of conversation until the storm was over. The epitome of this expression came during the opening ceremony of the Olympic Games in Sydney, during a scene lasting more than ten minutes. The whole stadium was filled with corrugated iron sheets and tanks, dancing to the tune of The Tin Symphony. As the commentator remarked: "What would Australia have been without corrugated iron?"

Corrugated iron has stood the test of time because of its enduring qualities. From the earliest times, man has always valued a product or material that will last and give durable service. After all, a good cooking pot or sword would be passed down from generation to generation and become the stuff of legend within a family or community.

Corrugated iron, or galvanized sheeting, was first made in London around 1830 when cropped and profiled steel sheets were hot dip galvanized by way of the conventional dipping method, the coating lacked the ductile properties of continuously galvanized sheet but because of the thicker coating obtained as well as the presence of corrosion resistant Fe / Zn alloys within the coating structure, examples of remarkably long rust free protection in mild to moderately corrosive environments are on record. The sheets were exported to the colonies such as Australia and South Africa as an excellent, ready-made building material.

During the gold and diamond rushes of the second half of the nineteenth century, building material was in great demand. Sheets of corrugated iron were shipped out from England and transported (sometimes vast distances from port) by ox or horse wagon, and then erected largely by unskilled building labour. Virtually every house, shop, church or shed was roofed with this material and it was to prove effective and long lasting.

In many of the old mining towns in South Africa, painted hot dip galvanized corrugated iron sheeting still functions as an effective roofing material.

To this day, there are many buildings in the outback of Australia or in old mining towns in South Africa where such roofs still function. General Smuts' home in Gauteng is a fine example of a corrugated iron roof still functioning. Some modern buildings and homes are also still designed with corrugated iron roofing, if the architect so specifies it.

Apart from homes, farms and offices this roof sheeting is also used for tanks, farm reservoirs, grain silos and culverts. A secondary role has come into play with the re-cycling of the material for informal buildings. With the influx of people to urban areas in South Africa, building materials are again in short supply and so "second-hand" corrugated iron roofing has become very valuable. Its value lies in its portability, effectiveness, durability and ease of erecting.

Nobody can argue that corrugated iron has not served mankind well over the last 160 years or so. It has great durable qualities, is easily recycled and at the end of the day can even be finally melted down for scrap. As a by-product of steel, which is extracted from iron ore, it is a sustainable, eco-friendly building material which will continue to prove its worth for decades to come.

Second hand corrugated iron sheeting is invariably used as the most desirable material for roof and side coverings of many informal shacks built in South Africa.

Temporary miner's house of 1880's Johannesburg gold rush, tourist attraction of 2002.

Jeff Thompson's corrugated iron car, Te Papa Museum, Wellington, New Zealand.

Today modern technology has resulted in the development of the highly efficient continuous hot dip galvanizing process whereby steel coil is decoiled and passed through the processing plant at high speed prior to profiling and cropping to size. This was originally described as the Senzimir process which provides an extremely ductile galvanized layer which is why subsequent profiling does not damage the protective coating.

Continuously hot dip galvanized roof sheeting is produced to various coating standards. The most frequently used product is Z275 (average zinc thickness about 19µm) while Z600 (average zinc thickness about 42µm) is the ideal product for use in environments where atmospheric corrosion is aggressive.

Over a century ago, Paul Kruger, President of what was then the Transvaal Republic imported corrugated iron roof sheeting for his farmhouse situated near Rustenburg. On arrival after several months, it was found that there had been a miscalculation and insufficient sheets had been ordered. In his wisdom, Paul Kruger had the oxen in spanned and by rolling the wagon wheels over the corrugations, the sheets were widened sufficiently to provide the required coverage!

Rumour has it that the above story was the forerunner of the saying, " n boer maak 'n plan"

These hot dip galvanized corrugated iron sheets have provided a service life of more than 100 years despite the somewhat flattened profile.

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Al Stratford: personality profile

Although design of this open air meeting place was the major criteria, material sustainability using treated timber, hot dip galvanized steel and sheeting covered in glass, was also a major consideration.

Al Stratford architect is best known in the construction industry for his invention of, and business in the WiNblok® pre-cast concrete window system which has become widely distributed throughout southern Africa and beyond.

He started his career with Dorbyl in East London as a structural steel draughtsman where he first came into contact with the benefits of HDG. After working as a technician for consulting engineers his interest in architecture drew him into his own business of designing and building houses at the tender age of twenty two. In the mid seventies he joined a multi-disciplinary firm of consultants in Durban where exposure to the full team of building professionals allowed him to acquire a broad based understanding of the industry.

One of Al Stratford's latest buildings, the Van Strien Plaza in Haven Hills, East London, an open air public meeting place.

From left to right: Al Stratford; Trish Emmet (President of SAIA); Malcolm Cambel (President of SACAP - Government); Sue Linning (Chief Executive of SAIA) and Martin Knoetze (Registrar for SACAP). [SAIA - South African Institute of Architects / SACAP - South African Council for the Architectural Profession].

He moved back to East London in 1980 and there built his own house using the WiNblok® concept. The response from architects to this product led to the founding of the company in 1984, the establishment of a 3000 m2 factory to produce the metal windows and the setting up of a franchised distribution network that manufactured the concrete components throughout southern Africa.

The WiNblok® system required a light weight steel section designed by Al, which is rolled in-house. A quality decision was made to hot dip galvanize all windows leaving the factory regardless of their destination, and to further enhance the product, a powder coating plant was installed to provide a colour via the duplex concept.

In 1994 he was invited to be a partner in an architectural practice which went on to win a national Award of Merit from the South African Institute of Architects for Al's new guesthouse and conference centre in East London. This same project was the overall winner in 2001 of the Industrelek Hot Dip Galvanizing Awards.

Al finally registered as a professional architect through peer recognition and on passing the professional practice exam as set by SACAP. He is currently the President of the Border Kei Institute of Architects and in this capacity serves on the national SAIA board.

Al and Iris, whose three grown sons have left home, live at Stratfords Guesthouse East London from which he runs his architectural practice.

Guest Writer

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

Productivity is man's sustained effort to improve, not an index to impress investors

Improving productivity is a key issue in all developed and developing economies. Investors demand higher turnover and profits per employee for continued investment. Governments need a higher gross domestic product per employed person to attract foreign investment.

In many developing countries like South Africa, modest improvements in productivity are being achieved mainly in the least desirable of ways: by reducing the number of employees in a company or the number of employed persons in the country. Although these improving statistics may begin to satisfy investors, they are of very little comfort to workers, taxpayers and citizens who have to live with the consequences of large-scale unemployment like crime, political instability and higher taxation.

Productivity should not be seen as just a statistical index based on output divided by input. It should also not be viewed as a fundamental economic measure of a technology's contribution. The economists' theory that expenditure on technology correlates directly with increased productivity sadly remains a theory. The 'productivity paradox' that computers have not boosted productivity is a real concern in many organisations.

Productivity is rather the manifestation of the human desire for improvement, achievement and progress. The application of their knowledge to existing processes, services and products is how humans bring about greater productivity. Applying knowledge to new ideas by way of innovation is also an important contributing driving force.

As 'knowledge workers', people use their knowledge by being told what they should be doing, not how they should be doing it. Unlike manual work, they concentrate their efforts on the results not on the task. Genuine productivity lies in performance and not in how one does things. Employees become 'players' rather than 'observers'. This is where technology often goes wrong: it focuses on how things are done, not on performance.

Technology does, however, provide one of the important requirements for knowledge: information. Many managers want to see more tangible results from technology than intangible knowledge and use information for 'warehousing' and 'housekeeping' purposes. They often fail to recognise that the main benefits of technology are to inspire humans to innovation and greater knowledge.

Information for knowledge requires a different type of leadership. Information cannot be hoarded and used as a source of power over others. Its flow must be 'horizontal' to all departments and not 'vertical' from top to bottom. Crucial strategic information must not be withheld from those lower in the organisation in the belief they couldn't handle it. As much information as possible should also be provided to other stakeholders such as suppliers, customers and even competitors. The 'new' economy is showing that the more you share with the rest of the world, the faster everyone learns. 'Command and control' leadership has to give way to 'let go' leadership.

Information alone is not sufficient for knowledge; skills are required. In the past, managers paid lip service to the idea of their employees being their most important asset and to the need for continuous training and development. In most companies, personnel training and development remained a 'nice' idea. Millions of Rands were readily justified to buy new technology. Expenditure for training and development, on the other hand, was considerably smaller and far more difficult to justify. Fortunately, of all the key areas for success, training is the one that seems to be changing the most.

Productivity is not arithmetic. It is not the manipulation of output and input numbers so as to produce an attractive ratio. Until such time as robots manage and operate our factories and businesses, productivity is intimately connected with human endeavour and performance. Improvements in productivity rest in human potential not in the number or complexity of machines. We must impress likely investors by the quality of our people not by any upward movement in an economic index.

"You cannot mandate productivity, you must provide the tools to let people become their best".

Steve Jobs

Walter's Corner

Corrosion: The common enemy

Corrosion costs the industrialised nations vast sums of money annually. South Africa as a developing industrialised nation is no exception. Estimates indicate that the annual costs of corrosion probably exceed 5% of our gross national product.

The good news is that by correctly implementing existing corrosion prevention technology, these costs can be reduced by about two thirds. Corrosion can be defined as "the undesirable deterioration of a material through a reaction with its environment". It is a complex mechanism which can take some fifteen different characteristic forms depending on the material and its environment.

When assessing the potential for corrosion in a specific case, knowledge of the environmental conditions is essential. When deciding upon the most appropriate method to combat the impact of corrosion, various measures require to be considered. These include: modifying the environment, appropriate design and correct material selection. The provision of barrier protection by way of a protective coating is the method most frequently used.

Organic paint systems are invariably the first choice when it comes to the provision of barrier protection. On the other hand, barrier protection provided by way of a metal coating is frequently a justifiable alternative. Zinc protection by way of hot dip galvanizing, continues to play an ever increasing role in combating corrosion in numerous applications, so much so that it is often referred to as a reliable "general purpose corrosion protector". To accept the misinformed salesman's general claim that paint provides better protection than hot dip galvanizing or alternatively that of the galvanizing salesman that galvanizing is far superior to a heavy duty paint system, is irresponsible unless substantive technical facts can be provided to support the claim in a specific case.

Confrontation is rarely a solution to a problem, while viewing your competitor as an enemy is both negative and counter productive. Constructive co-operation supported by enthusiastic research and practical action is in the long term far more rewarding. To illustrate, by combining the valuable attributes of a heavy duty paint coating with the undoubted attributes of a hot dip galvanized coating, spectacular long term corrosion protection is possible in numerous diversified applications. Unfortunately, the benefits of this concept are yet to be acknowledged and implemented by many specifiers and consultants despite the fact that positive evidence derived from long-term practical case studies is available.

Some 4 decades ago, I was struck by the title of a technical document published by an expert in the South African paint industry. It stated "Hot dip galvanizing, the ideal primer on which to apply a paint system". Prior to this and in subsequent years, I was privileged to be associated with a Dutch expert who commenced his corrosion control career as a paint chemist in Switzerland. This was after a distinguished career in the Dutch underground movement during the Second World War. His bravery was acknowledged in the form of a knighthood bestowed by Queen Wilhelmina of Holland.

During his primary years, this paint chemist, Jan van Eijnsbergen researched the merits and demerits of heavy-duty paint systems and hot dip galvanizing in corrosive applications. This led to the final conclusion that a combination of a good paint coating with a heavy duty hot dip galvanized layer is the most effective form of corrosion protection in most applications.

Jan van Eijnsbergen's research and recommendations are contained in a publication entitled "Duplex Systems (hot dip galvanizing plus painting), first published in 1994. This book contains valuable technical information.

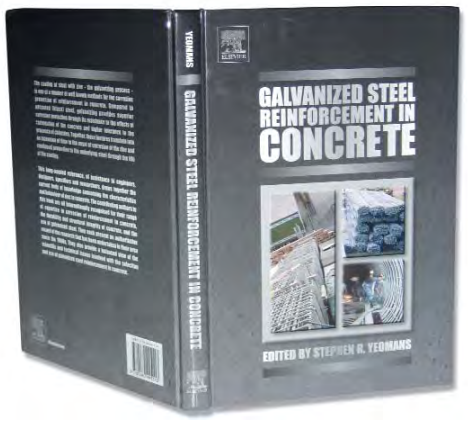
Encouraged by this development, the hot dip galvanizers invited the paint fraternity to form a combined committee to evaluate the effectiveness of duplex coatings as well as to develop appropriate paint specifications and application procedures. The co-operation between paint and galvanizing organisations was outstanding and this led to the publication of two documents, the first of which specifies appropriate paint systems for use in conjunction with a hot dip galvanized coating while the second is a code of practice for paint application.

What does all this teach us?
We are fighting a common enemy that is corrosion. To fight each other for supremacy is inexcusable, to unite our efforts is the professional approach that is in everyone's interest. What better example than the Duplex concept!

Book Review

Hot Dip Galvanized Steel Reinforcement in Concrete

edited by Stephen R. Yeomans from the University of New South Wales, Canberra, Australia



Hot Dip Galvanized Steel Reinforcement in Concrete, edited by Stephen R. Yeomans from the University of New South Wales, Canberra, Australia is available from the Hot Dip Galvanizers Association of South Africa.

The book promotes the merits of using hot dip galvanizing to protect rebar in concrete. The process has long been an accepted means of protecting steel reinforcement and other embedded components against corrosion in concrete.

After a period of restricted use during the late 1970's and early 1980's there has been a growing interest in and market demand for hot dip galvanized reinforcing steel over the last decade in particular. This has come about as a result of the publication of fundamental and applied research and a growing database on long-term field performance of hot dip galvanized reinforced concrete structures.

A significant shift in thinking has also followed relaxation in restrictions on the use of hot dip galvanizing for corrosion protection of reinforcement in concrete highway and bridge construction in the USA.

It was clear that a pressing need existed for an up-to-date and comprehensive collection of technical information and data in this area. This book is intended to bridge the gap between the previously published document of this type, produced in 1981.

In the preparation of this book, Prof. Yeomans has as contributors a group of eminent international figures from academia, research and industry, well known for their work in the concrete, corrosion and corrosion protection areas. They bring a level of technical detail and accuracy in reporting the facts and collectively present a fair and balanced record.

The book is targeted at a wide audience from end users, suppliers, specifiers and engineers to students, teachers and researchers. For each, varying levels of both technical information and descriptive material are presented.

It has taken several years to complete this project and thanks are due to the contributors for the care and attention taken in the preparation of the book.

Published by the International Lead Zinc Research Organisation (ILZRO), the book is available at US$150.

For enquiries on the book contact the HDGASA.

2005 Eskom Hot Dip Galvanizing Awards

Objective

To recognise and promote the development, application and use of hot dip galvanizing and related technology for corrosion protection purposes.

Categories

- Vintage
- Duplex Coating Systems
- Research & Development and Innovation
- Mining and Industrial
- Architectural
- Export

Vintage:

Long-term, maintenance free corrosion protection of hot dip galvanized and/or duplex coating applications that are 10 years or older.

Duplex Coating Systems:

Hot dip galvanizing plus an appropriate paint system, suited to the environment, aimed at longevity and/or aesthetics.

Research & Development and Innovation:

This category recognises research & development and Innovative work carried out by galvanizers, universities, technikons, professional institutions and end users. For example:

- Where a significant contribution has been made to expand the knowledge of the hot dip galvanizing process.
- Where the characteristics of the zinc coating or the application of the coating has been considerably improved.
- Where innovative design or a novel process or procedure has been facilitated to improve the coating.
- Where in a specific application, the concept of hot dip galvanizing or a duplex system has made a newly developed product or project unique.

Conditions of Entry

- The judging panel will, at its discretion, change the category of the entry where it deems such a change would benefit the applicant and where it maximises the value of the award to the industry in general.
- Only new submissions will be accepted, other than previous projects now qualifying for the Vintage category.
- At the discretion of the judges, the overall winner will not necessarily be a winner of one of the individual categories.
- The product or project must be

complete before being submitted.

- All entries must be submitted to the Hot Dip Galvanizers Association, Unit U4 (Upper level), Quality House, St Christopher Rd, St Andrews, Bedfordview, Johannesburg, on or before 31 May 2005.
- The judge's decision is final and no correspondence will be entered into.
- By submission of an entry, the nominator assumes responsibility for the accuracy of all information, and provides the HDGASA with assurance that permission has been obtained from the developer/ owner.
- The professional standard of the submissions form an integral part of the judging criteria.

Material to be submitted

- Submissions shall include a minimum of 5 full colour photographs. If digital photographs are to be supplied, kindly ensure that they are taken at 300 dpi for reproduction purposes.
- Kindly ensure that electronic copies of all digital photographs are supplied on CD with entry.
- The motivation shall include:
  - Name of product / project
  - Description of product / project
  - Application
  - Location
  - All project partners (spelling accuracy is important)
  - Quantity of steel hot dip galvanized or duplex coated
  - Inception / commissioning date
  - Value
  - Future potential, etc.

Entry forms and a user-friendly template with criteria prompts to assist entry and subsequent judging, will be forwarded to all interested parties.

Kindly contact Saskia at the HDGASA for further details.

2004 Prominent Projects Category Winners

The 2004 Prominent Projects Category winners recipients were unable to attend the awards function. With the kind assistance of Andre Albertyn of Sigma Consulting, Terry Smith had the pleasure of presenting award certificates to some of the project team at a casual gathering in Port Elizabeth.

(Although Colin Botha of Triple-S Structural Steel Services received a certificate, the photo could not be reproduced.

Greta Teltshick of Stauch Vorster.

Andre Albertyn of Sigma Consulting.

Grové Lourens of SBT Construction.

Ian Parker of Galvanising Techniques.

MISCONCEPTIONS

Miss Conception puts it "straight"

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

Once rust stains appear on a weathered hot dip galvanized surface you can be sure that the coating has reached the end of its protective life.

True or False?

With organic coatings, adhesion is achieved by way of a mechanical bond between the coating material and the substrate.

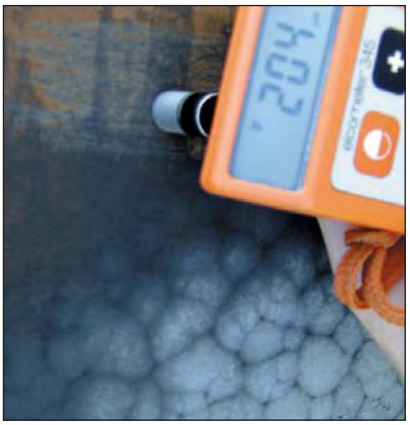
Hot dip galvanizing is somewhat different in that adhesion is provided by a diffusion process, whereby atoms of zinc and iron combine to form a series of iron/zinc alloys at the steel zinc interface during the period that the steel is in contact with molten zinc. In most cases, these hard abrasion and corrosion resistant alloys make up at least 50% of the overall thickness of the final coating. Depending on minor variations in steel composition, these alloys can grow profusely to the extent that not much unalloyed and relatively pure zinc is present on the coating surface. Inevitably, the overall thickness of such coatings is normally greater which enhances their protective life. There is of course a limit to what is desirable since excessively thick iron/zinc alloys can be brittle and prone to mechanical damage.

When these hot dip galvanized coatings are exposed to the environment, the relatively thin outer zinc layer gradually weathers away thus exposing the alloys of iron and zinc. If these alloys are exposed to moisture and oxygen, a degree of red rust staining can develop and this is frequently assumed to be rust emanating from exposed steel, which is not the case. It is in fact the iron within the coating that causes their surface staining.

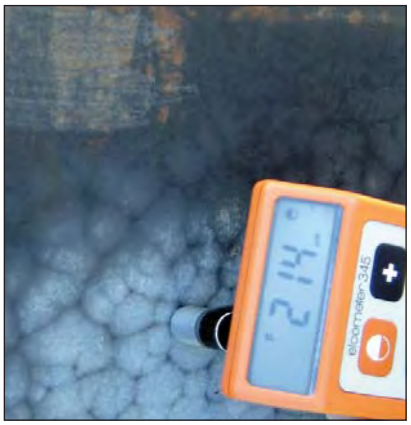
The rust staining often appears adjacent to a mottled grey coating, see photos. The latter surface condition is often misconstrued as cracking of the coating. The dark grey lines in the pattern are not cracks but are indicative of the grain boundaries of the steel, highlighted by the presence of extensive iron/zinc alloy phase growth, caused by steel with high reactive levels of Silicon and Phosphorous, either separately or in combination.

Appearance can be misleading. Measuring the remaining coating thickness with an instrument, which operates on the magnetic principle, is the only reliable way to determine the actual condition of the hot dip galvanized coating.

While these thicker coatings invariably provide longer corrosion free life, the downside is that they are not as pleasing to the eye, due to the presence of dull grey surface patches. If aesthetics are important as in the case of architectural features, the pre-selection of steel with respect to its silicon and phosphorous content will overcome this problem.

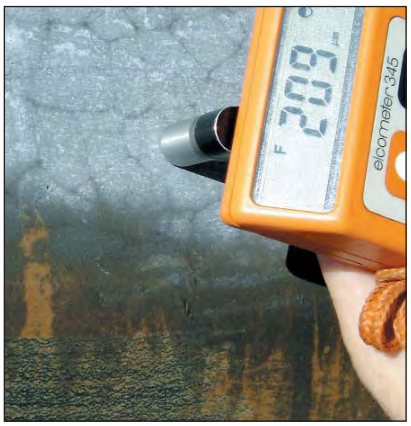


Coating thickness on rust stained area (204 microns).



Coating thickness on on adjacent mottled grey coating (214 microns).

Coating thickness on rust stained area (180 microns).



Coating thickness on on adjacent mottled grey coating (209 microns).

HOT DIP GALVANIZING OF WIRE

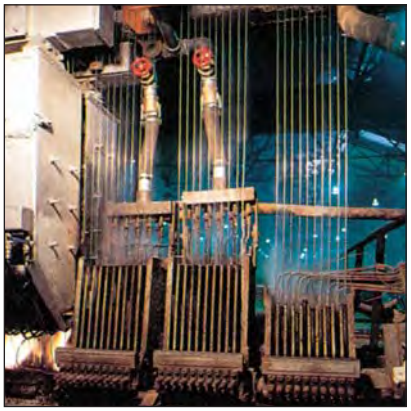
Hot dip galvanizing of wire

The Process

Hot dip galvanized fencing wire is produced from mild, high tensile or very high tensile steel wire, on a continuous coating line which includes annealing, acid cleaning, fluxing, galvanizing, wiping to remove excess zinc and recoiling of the finished wire. The process is similar in arrangement to the Sendzimir process used for continuous galvanizing of sheeting. Between 20 and 40 individual wires are hot dip galvanized simultaneously by passing through a molten zinc bath held at 450 degrees celcius.

For the production of thick coatings, the wire normally leaves the zinc bath vertically, but for the thin coatings, the wire leaves the bath either obliquely or vertically. An even coating is obtained by wiping the wire as it exits the zinc bath and this helps to control the coating thickness. For the thick coatings, the wires are drawn either through a bed of charcoal or some propriety product, or in more modern plants, are gas or jet wiped. For thin coatings fibre pads are traditionally forcibly pressed against the wires by various methods. Different to general hot dip galvanizing where ductility is diminished due to at least 50% of the coating comprising iron/zinc alloys, hot dip galvanized wire must be ductile and therefore has an extremely thin iron/zinc alloy layer. This is mainly as a result of the speed of which the wire passes through the molten zinc, drastically shortening the immersion time. It is for this reason that hot dip galvanized wire can readily be bent to make chain-link fencing or even products such as barbed wire, where greater deformation is needed. Thicker coatings are controlled by the specific process involved. For example in jet wiping, the coating weight is controlled by varying the nitrogen pressure surrounding the wire. This can be done manually or automatically using computer controlled coating weight sensors.

The coating thickness is generally related to the diameter of the wire being processed, as is recognised in the hot dip galvanized wire standards. The life of a hot dip galvanized coating is also relative to the coating thickness. The thicker the coating the longer it will last in a given environment. Two specifications cover wire galvanizing in South Africa. They are SABS 675 (SANS 675) and SABS 935 (SANS 935), the former specification was amended in 1993 to include only one class of coating for fencing products i.e. a heavy zinc coating. The latter specification includes three classes of which only the class 1 is equivalent in coating thickness to SANS 675. See table 7. Fencing material failures are not always due to the failure of the zinc coating and frequently occur when wire of unsuitable tensile strength is selected. See table 10. Damage to the coating may also arise during erection and result in localised



Thicker coatings are produced when the wire exits the bath vertically.

Bales of galvanized wire ready for distribution.

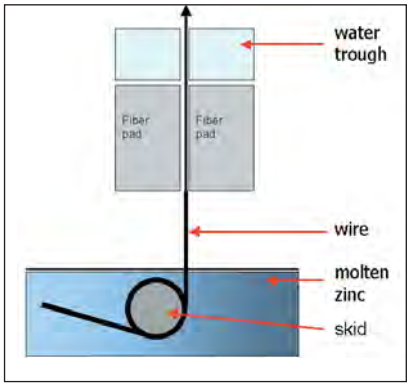


Diagram showing the pad wiping process.

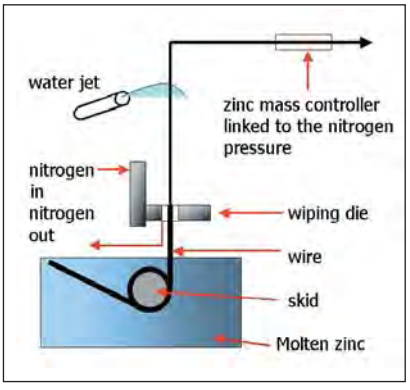


Diagram showing the jet wipe process.

DATES TO DIARISE 2005

APRIL 2005

13 April – HDGASA Golf Day – Royal Jhb

AUGUST 2005

19 August – 2005 Eskom Hot Dip Galvanizing Awards – The Castle, Kyalami

NOVEMBER 2005

25 November – AGM & Year End Function – Zincor, Springs

1	2	3
Nominal diameter of zinc coated wire mm	Minimum mass per unit area of zinc coating g/m²	Approximate equivalent average thickness µm
1,20 - 1,50	215	30
1,51 - 1,80	230	32
1,81 - 2,20	245	34
2,21 - 2,50	260	36
2,51 - 3,50	275	38
3,51 - 5,00	290	40

Table 7 – Mass per unit area of the zinc coating.

Dimensions in millimetres		
1	2	3
Wire diameter *d*		Mandrel diameter
Over	Up to and including	
-	3,8	4*d*
3,8	5,0	5*d*

Table 8 – Mandrel diameter.

Dimensions in millimetres	
1	2
Diameter Range	Tolerance
up to 1,80	± 0,05
1,81 - 3,00	± 0,08
3,01 - 5,00	± 0,10

Table 9 – Tolerance on diameter.

1	2
Grade of Steel	Tensile Strength MPa
Mild (M)	350 - 575
High Tensile (HT)	1 050 min.
Very High Tensile (VHT)	1 400 min.

Table 10 – Tensile strength of galvanized wire.

corrosion and rust staining if unsuitable tools are used. Wire complying with this standard will in time exhibit changes in mechanical properties if it is compared with newly zinc-coated wire. The changes due to strain aging or strainage hardening could result in an increase in tensile strength and a decrease in elongation.

Adhesion of zinc coating

Test the adhesion of the zinc coating by wrapping a suitable length of wire at least six close turns round a cylindrical mandrel. Choose the ratio of mandrel diameter to wire diameter in accordance with table 8. When tested in accordance with the above, the coating shall remain firmly adhered to the underlying steel wire and shall not crack or flake to such an extent that any flakes of coating can be removed by rubbing with the bare fingers. Loosening or detachment of superficial, small particles of zinc during the test, formed by mechanical polishing of the surface of the zinc-coated wire, shall not be considered cause for rejection. Small particles of zinc, formed as globules on the surface during zinc coating, may loosen or become detached during the test. These shall not be considered cause for rejection either, provided that no bare spots (exposed steel) are present.

Diameter of zinc-coated wire

Except in the case of oval wire the cross-section of the wire shall be circular. The nominal diameter(s) of the zinc-coated wire shall be in the range given in column 1 of table 9, as required. The actual (measured) value(s) of the diameter(s) shall equal the nominal value(s), subject to the appropriate tolerance given in column 2.

Uses of wire: Fencing

Requirements for a good fence

A good fence should have the following features:

- It should be in a perfectly straight line from corner post to corner post with all standards and droppers in perfect alignment.
- The corner and gate posts should be sturdy, be set vertically into the ground and be anchored.
- All standards and droppers should stand erect and maintain the same height above ground level.
- The closer the standards and droppers are together, the more sturdy the fence.
- Irrespective of the number and type of wire strands used, each should be at a specific height above ground level, be parallel to the other and be well secured to each standard in such a manner that it cannot be shifted vertically. The more wire strands in a fence of a particular height, the more difficult it is for man or animal to creep through them.
- Droppers must be spaced so that the distances between the standards are equally divided; they must stand erect and the wire strands must be securely tied to them at the same spacing as on the standard.

A good fence can never be erected with inferior material.

The height of a fence

The purpose will determine the height, the number of stands and (if required) the type of manufactured fence, to be used.

Domestic

The average height of a boundary fence on a domestic property will be at least 1200m.

Several options are available to the owner regarding the type of fence to be installed.

a) A boundary fence of plain hot dip galvanized wire, barbed wire or a combination of the two consisting of 6 strands. It is also accepted that the spacing from ground level to the first strand is 150mm.

b) A boundary fence is normally diamond mesh with an aperture of 75mm and the diameter of the wire of 2,00m. The mesh must be supported by at least three straining wires of 4,00mm, with the bottom straining wire 50mm from the ground level. The mesh is attached to the top straining wire at each aperture, to the bottom straining wire at 150mm

WIRE TYPES

CABLE ARMOURING WIRE

Diameter range:	0.90 to 3.55mm
Tolerances:	± 0.04 to ± 0.10mm dependent on nominal diameter
Tensile strength range:	MPa 350 to 550
Zinc coating:	SABS 935, BS 443, ASTM and JIS
Packaging:	350 - 1000kg continuous pattern laid coils
Typical applications:	Electrical cable armouring
Transportation:	By road, rail, sea as per customer requirements

LIGHT GALVANIZED MILD STEEL PROCESS WIRE

Diameter range:	0.71 to 8.00mm
Tolerances:	± 0.04 to ± 0.08mm dependent on nominal diameter
Tensile strength range:	MPa 350 to 900
Zinc coating:	SABS 935, ASTM, JIS
Packaging:	350 - 1000kg continuous pattern laid coils
Typical applications:	Industrial products, Fencing applications, Welded products, Coat hanger hooks, Screening

PLATING QUALITY WIRE

Diameter range:	3.00 to 7.00mm
Tolerances:	± 0.02 to ± 0.08mm dependent on nominal diameter
Tensile strength range:	MPa 550 to 750 in ranges of 150 MPa
Packaging:	80 - 300kg catchmass coils, 1000kg layer wound packs
Typical applications:	Stove oven racks, Kitchen utensils, Lever arch files

HEAVY GALVANIZED MILD STEEL PROCESS WIRE

Diameter range:	0.90 to 6.00mm
Tolerances:	± 0.04 to ± 0.10mm dependent on nominal diameter
Tensile strength range:	MPa 350 to 900
Zinc coating:	SABS 935 / SABS 675, BS 443, ASTM, JIS
Packaging:	350 - 1000kg continuous pattern laid coils
Typical applications:	Industrial products, Fencing applications, Welded mesh, Gabions

END ANNEALED WIRE

Diameter range:	1.60 to 4.00mm
Tolerances:	± 0.02 to ± 0.05mm dependent on nominal diameter
Tensile strength range:	MPa 350 to 500
Packaging:	50, 150 to 300 mill coils 45kg spooled coils
Typical applications:	Waste paper baling / Steel fixing

HARD DRAWN MILD STEEL PROCESS WIRE

Diameter range:	0.90 to 11.80mm
Tolerances:	± 0.02 to ± 0.08mm dependent on nominal diameter
Tensile strength range:	MPa 350 to 1200 In ranges of 150 MPa dependent on diameter and rod quality
Packaging:	80 - 300kg catchmass coils
Typical applications:	Nail manufacture, Concrete reinforcing, Stove oven racks, Refrigeration / freezer racks, Welding electrodes, Welded mesh products, Automotive industry

COLD HEADING WIRE

Diameter range:	2.80 to 11.72mm
Tolerances:	As per customer request (mm)
Tensile strength range:	MPa 350 to 500
Packaging:	80 - 300kg catchmass coils
Typical applications:	Bolt and screw manufacture / Rivets / Blind rivets

LIGHT GALVANIZED HIGH TENSILE UNITISING AND BAILING WIRE

Diameter range:	2.3 to 11.72mm
Tolerances:	± 0.04 to ± 0.06mm dependent on nominal diameter
Tensile strength range:	MPa 950 to 1500 In ranges of 150 MPa
Zinc coatings:	SABS 935
Packaging:	350 - 1000kg continuous pattern laid coils
Typical applications:	Paper pulp baling, Household waste baling, Razor barb core

Wire recoiling subsequent to galvanizing.

Most prisons have elaborate perimeter fences.

intervals and to the intermediate straining wires at 300mm intervals with 1,60mm tying wire.

c) An anti-intruder fence should, at least, be 1800mm in height, using diamond mesh with an aperture of not more than 50mm and diameter of the wire of at least 2,50mm. If possible, diamond mesh with one edged barbed should be used. The mesh must be supported by at least three staining wires of 4,00mm, the bottom straining wire 50mm from ground level. Barbed wire should be strung above the mesh in positions indicated by holes in the extension arms. Droppers to stiffen the barbed wire are optional.

The bottom of the mesh should be anchored to the ground by means of either hairpin staples of 3,5mm shall be circular thickness embedded in a continuous concrete sill to depth of at least 150mm at a maximum spacing of 1m, or with 8,00mm anchor pegs driven into the ground to a depth of at least 400mm at a maximum spacing of 1m.

Agricultural Farms

The type of stock kept will determine the height and the number of strands of wire to be used in a fence. For a combination of large and small stock and for large stock, a fence should never be lower than 1200mm. Where sheep only are kept, fences should not be lower than 900mm with a minimum of 5 strands. The height of a fence is measured from the ground to the highest wire strand. Fences which are to contain both sheep and angora

These hot dip galvanized posts are designed to support pre-tensioned hot dip galvanized wire ropes forming part of the safety barriers installed in high risk accident areas.

A display of wire-related handmade art on the roadside on the outskirts of Cradock.

goats should be 1050mm high, with at least 7 strands of wire. To discourage fence-jumping amongst large stock, it is sometimes necessary to make a fence 1350mm high, with at least 5 strands of wire. For a fence of this height to contain mixed stock effectively, at least seven wires are essential. All posts and standards should also be at least 150mm longer than those used for a fence 1200mm high.

Game Farms

Game farming has become popular in recent years. It is inevitable that fences which are to contain game will demand more as far as strength and quality are concerned. The following minimum requirements have been laid down for game proof fences.

Group I Game:
Kudu, Eland, Impala, Waterbuck, Buffalo – 2,4m high with 21 strands.

Group II Game:
Gemsbok, Red Hartebeest, Gnu or Wildebeest, Sable Antelope, Zebra – 1,8m high with 16 strands.

Group III Game:
Blesbok, Bontebok, Springbok, Rhe-Buck and other small game – 1,4m high with 13 strands.

Group IV Ostriches:
Although not strictly game in the true sense of the word, there are many similar behaviour traits – 1,8m high with 6 wire strands, which must be plain wire. For ostrich chickens, wire netting is used.

Mechanical properties of wire

Approximately 50% of the material cost of a fence is in the wire component. consequently, it is important to select the correct type of wire for a given application, at the most economical cost.

Types of wire:

There are two basic types of wire available in South Africa, namely:

1. Soft or plain wire
2. High strain steel wire

These wires differ in that they have different chemical composition and different physical properties and performance in a fence.

Breaking Load:

The breaking load is the maximum load that a wire can sustain before breaking.

Breaking load is expressed in kilonewtons: one kilonewton is equal to a force of 101,793kg.

Elasticity:

A fence wire behaves elastically up to a certain load. It can stretch when a load is applied, then return to it's original length when the load is relaxed.

Elastic Limit:

After a certain load has been applied to the wire, the wire will reach a point where it will not return to it's original length. (i.e. it has been stretched) This load limit is referred to as the yield point or elastic limit. The yield point of any wire can be regarded as approximately 75% of the breaking load. The amount of elongation produced by the same load will depend on the diameter of the wire. As such, a thinner wire will elongate more than a thicker one and is said to have a higher elasticity. This also means that a thinner wire will lose less tension than a thicker one.

Length of Strain:

The length of strain has a direct effect on the amount of tension that will be retained in a wire once it is strained. The longer the strain the less tension will be lost. As a guide for fences strained to a similar tension under similar conditions, if one is twice as long as the other, the loss of tension will be halved. Similarly for a fence half the length, the loss of tension will be doubled.

Environmental effects on fence wire

Effect of Temperature of Fence Wire:

Wire is affected by temperature variations. As the temperature drops,

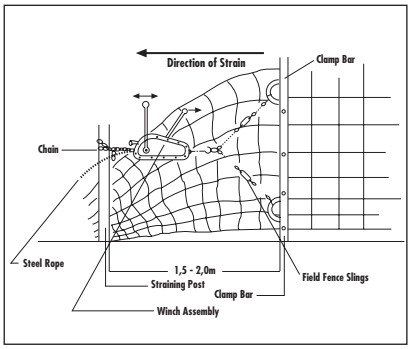


Diagram showing a winch assembly and clamp bar used for erection of a field fence.

wire will contract, increasing the tension in the wire, and as temperature rises, the wire will expand, decreasing the tension. The change in length is similar for all types and thickness of wire, however, the resultant change in tension depends on the wire's elongation and will therefore differ with wires of different diameters. It is the increase in tension, due to cold weather, that causes major problems in a fence. During cold temperatures the fence will contract and this will increase tension in the wire and also on the straining posts. This could result in strainer post movement and when temperatures increase the wires will slacken further. If these factors are taken into account, then allowance can be made for temperature variations if necessary. As the thinner wires have a higher elongation rate, they will not be effected to the same degree as a thicker wire. For each 5 degrees C above or below 15 degrees C, subtract or add the following tensions when straining a fence:

4,00mm	200	Newtons
3,15mm	100	Newtons
2,50mm	50	Newtons

Protective coatings:

All fencing wires are supplied with a hot dip galvanized coating. The hot dip galvanized coating provides a slowly corroding barrier, which for its service life is generally predictable. Should the coating become damaged or is cut, zinc will corrode in preference to the steel under natural conditions. While zinc is present, corrosion of the wire is impossible, this process is known as sacrificial corrosion.

In this process, the zinc corrodes completely before steel corrosion commences; thus the life of the wire can be divided into two separate components, the life of the zinc coating and that of steel.

Corrosion rates vary considerably. Coastal areas can be much more corrosive than inland areas, in turn

Location	Loss of zinc coating thickness in µm per annum	Zinc mass loss in g/m² per annum
0.5 to 3km from sea	6 to 15µm	42 - 105
40 to 100km from sea	1 to 2µm	7 - 14
Industrial	1 to 3µm	7 - 21
Rural	Less than 1µm	Less than 7

Table 11 – Approximate coating loss per annum.

the atmosphere in industrial areas can be more aggressive than coastal areas. The useful life of the zinc coating is directly proportional to the thickness of the coating, irrespective of the thickness of the wire. Most wire galvanizers supply two types of hot dip galvanized coatings to prevent corrosion: - Lightly Galvanized -and Heavy Galvanized. The heavy galvanized wire has more than three times the weight of zinc compared with lightly galvanized products. Therefore, heavy galvanized products will have a much longer life than lightly

Hot dip galvanized wire is frequently used for reinforcement in gunite type coatings, to restrain potential rock bursts underground in mines.

The containing rings of the Mesh Pack Grout Support System are light and easy to carry underground.

galvanized products. Heavy galvanized coatings are frequently specified for high strain steel wire.

Heavy galvanized coatings should always be specified for areas where corrosion is known to be a problem. In abnormally corrosive situations such as near the sea or in areas where ground salts are prevalent, even heavy galvanized wire may have a relatively short life.

Expected life Span:

The expected life span of galvanized wire is affected by many factors. Extensive atmospheric testing in various parts of South Africa, by the CSIR revealed the following loss of zinc thickness per annum (see table 11). These average figures may vary from area to area, depending on varying atmospheric conditions.

Fire Damage to Wire:

When comparing the performance of different wires in the field, it is important that circumstances are similar in every respect. International studies carried out in these conditions indicate that: - Temperature, tension and wire diameters are the main factors involved. - Fire temperatures less than 400 degrees C do not affect the performance of any wire. - Failures in thicker soft wire could be expected to be less, because tensions will probably be lower. - Tension of any wire should not exceed 1.3kN (132kg) in high fire risk areas. - High strain steel wire, being thinner, requires less heat to raise it's temperature to critical levels.

To reduce the risk of fire damage to fences, keep vegetation off the fence and grade or clear tracks along each side of the fence. This also makes fences more accessible for maintenance and checking. Many landowners spray along fences with commercially available chemicals to kill vegetation.

Fencing products

Hot dip galvanized wire is supplied in two basic types:

- Soft Hot Dip Galvanized Wire and
- High Strain Steel Wire

Soft hot dip galvanized wire

Soft hot dip galvanized wire is supplied in diameters ranging from 0,71mm to 4,00mm. Generally speaking the 4,00mm and 3,15mm have in the past been used, as straining wires, for most conventional fencing applications, and are supplied with either lightly galvanized or heavy galvanized coatings. Being relatively soft, knots can be tied without difficulty. Their disadvantages are the additional cost and weight per kilometre, the need for closer spacing of straining posts and the difficulty of maintaining tension in the wire because of the lower elastic rates of elongation. This last point is quite critical should the straining post move slightly.

High strain steel wire

High strain steel wire possesses the advantage of being more economical, fences with long strains and fewer posts are possible and generally show an overall cost advantage.

Disadvantages include the slightly greater difficulty in handling, particularly tying of knots, and the need for more accurate straining. High tensile wire is available in the following sizes:

2,24mm (round),

2,00mm x 2,60mm (oval) and

2,00mm (round).

Both soft and high strain steel wire can be supplied in diameters other than those mentioned above subject; to special order and sufficient quantity.

Netting wire

Netting is usually utilised as a means of excluding vermin (jackals, rabbit etc.), and at the same time, controlling domesticated stock. The netting wire must be tied to the straining wires, standard and dropper with binding wire.

Diamond mesh

Diamond mesh is primarily used for domestic and commercial applications as a boundary fence.

Barbed wire

Barbed wire is generally used as a deterrent for stock rubbing against a fence (one of the main causes of damage), and where intrusion by humans is a problem.

Field fence

Field Fence is a prefabricated fence with vertical stay wire permanently, but flexibly joined to the horizontal

line wires. The stay wires are 2,50mm soft wire spaced at 150mm or 300mm centres. All line wires are 2,24mm high tensile wire with edge wires of 3,06mm high tensile wire. Field fence is suitable for the control of small stock, large stock, mixed stock, game and intruders. Due to it's construction it will withstand high stock pressure as each line wire has tension curves crimped into it during manufacture which also allows for expansion and contraction with extreme temperature changes. Erection of this type of fence is a relatively simple task. Two or more vertical stay wires are removed from the end of the roll. Starting with the center line wire, wrap the end of each wire round the straining post and back onto the line wires. Care must be taken to ensure that the bottom of the roll is at the bottom of the fence, the bottom of the roll is identified by the fact that the line wires are much closer together than they are at the top. Unroll the field fence, keeping the bottom wire close to the standards. A tension bar is attached to the other end of the roll approximately 1,5m to 2,0m from the second straining post. One or more wire strainers are attached to the tension bar and the fence is then raised and tensioned. The fence is properly tensioned when it is springy to the touch and the crimped tension curves are half straightened out.

Other uses

Welding wire, nails, screws,staples, gabions, mattresses,terramesh units and rockfall protection netting.

The Association wishes to acknowledge with thanks the contributions from – Cape Gate and CWI.

Meshpack grout support system outperforms timber as stope supports

A revolutionary underground support system has been developed as a viable alternative to traditional timber supports, by Johannesburg-based Industrial Netting and Mining Products.

The Meshpack is manufactured from hot dip galvanized diamond mesh surrounding a woven polypropolene bag. The bag is then filled with a special grout mixture made from tailings or slurry from the mine workings, mixed with an accelerating agent to help the setting. The mixture is pumped in from a grout supply hose attached to the bag.

The product has undergone extensive testing both at the CSIR and in situ underground, to measure the load carrying and impact capacity, as well as the yielding properties. It was found that the Meshpack outperforms any other method of stope support, both from a performance as well as installation point of view.

The containing rings are light and easy to carry underground and at one mine, a team of three was able to install nineteen packs in one shift. There is also a considerable saving on materials, as the costs of the diamond mesh and bag are considerably less than timber, not withstanding the added cost of the grout, which is largely a re-cycled product.

From a safety aspect, the Meshpack cannot burn or deteriorate like timber and there are no hazardous materials used in the construction. The grout sets within half an hour, after which the Meshpack becomes operational and can take a blast.

The Meshpack is yet another example of the uses to which hot dip galvanized wire can be used in a practical, cost-effective application.

Mining personnel at a horizontal installation of the Meshpack.

Protecting bridges with gabion baskets

Rivi-Rivi Bridge, Malawi

During the last rainy season, the bridge on Rivi-Rivi River in Balaka was extensively damaged and nearly washed away due to flush floods, following intense rainfall in the catchment area, which overwhelmed the river drainage system.

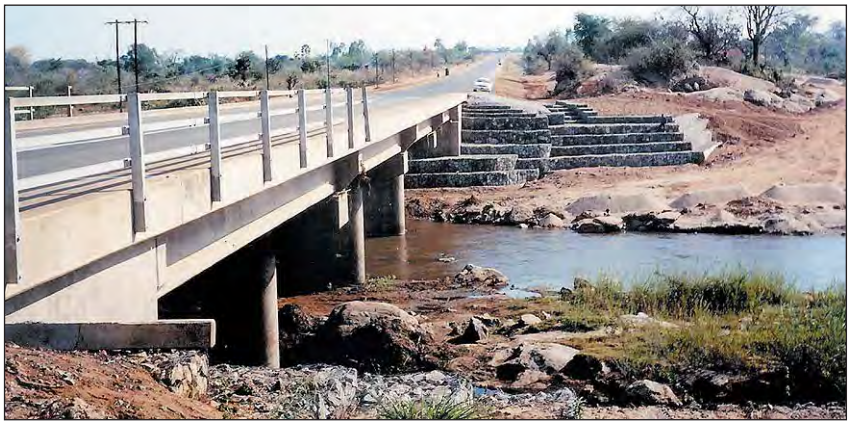
This section of the M1 road where the Rivi-Rivi Bridge is situated was constructed in the early 1980s. The bridge should have, therefore, also been designed round about the same time or earlier. In that time, it was adequately designed for this type of flood, with all the vegetative cover intact and with very sparse population in the area.

With the construction of the road, settlement increased and with the increase in population, has come its associated problems; viz uncontrollable cutting down of trees for fuel wood and charcoal, over grazing by domestic animals, and clearing up of vast areas of land for cultivation. As a result rainwater does not soak into the ground but rather runs off quickly, carrying all the topsoil into the river systems which adds to the run-off overload during consistent and excessive rains. This, in turn, resulted in damage to property, both the road and rail bridges and the approaching road sections.

On close examination of the damage to the bridge, one notices that the northern bank side, which had a properly constructed gabion basket protection wall and natural vegetation grown through the gabions, minimal damage, if any, took place. This is despite the fact that the northern approach bank withstood 90% of the flood force.

Trevor Hiwa, Resident Engineer of African Gabions in Malawi, said: "had it not been for this line of gabions, we could have been telling a different story today. Due to the inherent flexibility of the double twisted steel wire mesh, the gabions were able to flex and bend into the erosion, stopping further erosion and damage."

Other bridge protection techniques, notably concrete, stone pitching, and weld mesh gabions, being rigid, would simply have failed to bend, cracking in the case of concrete and stone pitching and would have eventually failed. It is quite evident therefore, that the Maccaferri gabion baskets saved the bridge from more excessive damage and maybe outright wash-aways, as was the case with the rail-bridge downstream which had no gabion protection.



With these unique features of gabions in mind, the National Roads Authority (NRA) contracted out the maintenance and restoration of the site to Fargo Limited by use of mainly Maccaferri gabion baskets to stabilise and protect the bridge approach abutments and the area around.

Maccaferri gabions are made from hot dip galvanized 2.7mm double twisted steel wire mesh. The galvanization allows the wire to withstand corrosion for up to 20 years. Where gabions will be in contact with chemicals or permanently in water, PVC coated gabions work best and have a life span of at least 40 years.

Maccaferri gabions are filled with locally hand picked stones. The stones fill up only 70% of the gabion baskets, leaving 30% voids. These voids allow plants to grow through and act as a home and shelter to small animals.

Deliberately introducing soil and planting shoots through the gabions can encourage plant life. The root system of these plants not only provides a natural soil protection but also allows the natural flora and fauna to re-establish within a short time.

Not only are gabions baskets structurally sound for erosion protection works, they are also environmentally friendly.

The Association wishes to thank African Gabions for this contribution.

Editors Note: ***The corrosion resistant life of 20 & 40 years mentioned in the article above, obviously depends on the environment at hand.***

New report on performance of zinc coated wires in the South African agricultural industry

The cost of fencing farmland and game ranches is considerable and can approach the land value itself, especially with respect to game fences which require high level fencing using up to 22 wire strands. To assist the farming community in the selection of suitable fencing wire material, the Agricultural Engineering Institute (AEI) began an atmospheric corrosion programme during 1990 on a variety of fencing wires. These included, light galvanized wire, heavy galvanized wire (both locally produced in South Africa), Galfan (95%/5% zinc/aluminium) coated and aluminium coated wire (both imported). A total of seven sites of varying atmospheric corrosivity in South Africa were selected for this AEI atmospheric corrosion programme. These were deemed to be representative of the various agricultural climates experienced throughout South Africa.

The final report was produced with support from the South African Bureau of Standards and the International Zinc Association Southern Africa (IZASA). The 11 year results reported reflect the *in situ* performance profile and are of practical interest. This data can be used as a platform to determine longevity of the wire types by extrapolation.

The main conclusions derived from the study are:

1. The use of light galvanized wire cannot be recommended in any of the sites tested. Where performance appeared adequate, it needs to be noted that any extraneous effects such as fire or excessive humidity due to tall grass coming into contact with the wire, may compromise performance of light coatings. The SANS 675 standard no longer includes the Class C (light) coating. The use of imported wire that does not conform to Class A (heavy) coating should be strongly discouraged. It is also recommended that should wire be specified to SANS 935:1993, "Hot Dip (galvanized) zinc coatings on steel wire", only Grade 1 (heavy) coatings should be used for fencing. Under no circumstances should either Grade 2 (medium) or Grade 3 (light) be considered.
2. The performance improvements available by using aluminium or Galfan™coated wires are such as to be only of real value in environments C3 and above. However, the cost of labour in replacing fencing would more than compensate for the higher initial cost of aluminium or Galfan™ fencing in many applications. This would have to be determined on a case by case basis. The variability of costs precludes such an analysis in this report. Some cracking was noted of the aluminium coating which could limit cathodic protection of uncoated (bare) spots. This could compromise long-term performance.
3. The corrosion performance of the heavy galvanized coatings corresponds well to that determined from previous studies and available climatic data. It is clear that this correlation allows the performance of galvanized wire to be determined from published corrosivity data with reasonable accuracy. Where deviations from predicted performance occur, this may be due to local effects of site climate (microclimates) and husbandry (grass height, maintenance, etc.).
4. No significant differences in corrosion rates of top and bottom wires were found. Therefore, a single material type would be suitable for all the installed strands at a particular site. It should be noted that good fence

maintenance would include reasonable effort to keep undergrowth away from the lower fence areas where a continuously wet poultice would accelerate corrosion.

5. Dropper effect on the corrosion rates of wires was found but was negligibly small. As a result no material system needs to be preferred over another.
6. Barbs did not significantly affect the corrosion rate of the metal coatings on the wires. The effect will probably only become significant once all the zinc coating is removed from the barbs. If this happens, the wire coating will also sacrificially protect the barb, thus causing increased rates of attack to occur. None of the barbs on the wires in the test lost all of its coating during the exposure period. Thus, the longevity of barbed versus smooth wire fences would be expected to be equivalent.
7. If the dry grass density near zinc-coated steel wire fences is below 0,5 kg per square metre, no damage to the wires occurs when the grass is set alight. Extensive damage to these wires occurs when dry grass with a density of 1 kg per square metre is set alight and allowed to burn through the fence. Good fence maintenance should include keeping fence areas as clear from tall grass as is possible.

Standards South Africa is now to embark upon a full review and rationalization process of all the wire and wire-related products and applications specifications using input from this study. In addition, an advise note will be issued with SANS 935 stating that, for fencing wires, only Grade 1 should be used.

A brochure has been produced which includes an update of the corrosivity map generated by the CSIR and provides advice on good husbandry to affect optimal wire performance.

The Association wishes to thank the IZASA *for this contribution. For further information contact the* HDGASA.

ZINC APPEARS TO IMPROVE CHILDHOOD HYPERACTIVITY DISORDER

Zinc supplements could improve effectiveness of treating children with attention deficit hyperactivity disorder (ADHD), a common childhood behavioural disorder that is believed to affect around one in 25 school-aged child. The effects of ADHD on individual children differ, but symptoms include inattention, hyperactivity and impulsiveness. Stimulants are the most common treatment prescribed, but some patients respond poorly to stimulants or are unable to tolerate them. Recent findings indicate that vitamin and mineral deficiencies correlate with ADHD, suggesting that dietary supplements could also play a role in disease management.

Research published this year by a team at Karadeniz Technical University in Turkey found that zinc sulphate reduced the symptoms of hyperactivity, impulsivity and impaired socialization in children with ADHD, particularly older children and those with low zinc levels. Another study of 44 children diagnosed with ADHD at Roozbeh Psychiatric Hospital in Tehran, Iran showed a marked improvement after six weeks in children that took a 55mg/day zinc sulphate supplement. Zinc supplements may exert their positive effects by helping to regulate the function of the neurotransmitter dopamine, suggested the researchers. Dopamine signalling, which has been implicated in causing symptoms of ADHD, is believed to play an important role in the feelings of pleasure and reward. The hormone melatonin, made by the body but requiring zinc for its production, regulates dopamine and has been shown to help regulate the sleep cycle of children with ADHD.

Source: Prog Neuropsychopharmacol Biol Psychiatry. 2004 Jan; 28(1):181-90. http://www.ncbi.nim.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=pubmed&dopt=Abstract&list_uids=14687872 and www.nutraingredients.com

Case History
No. 02/2005

HOT DIP GALVANIZED STEELWORK USED TO WIDEN THE STORMS RIVER BRIDGE IN DECEMBER 1986

The original rationale

"Hot dip galvanizing to SABS 763, heavy duty coating - 105µm, (now SABS ISO 1461 or SANS 121) was selected as the method of rust prevention for the balustrades, hollosec guardrails, stanchions, box girder ribs, drainage channels, some of the fasteners and the 'Vastrap Plate' footwalks. According to HHO Africa, then known as Hawkins, Hawkins and Osborn, hot dip galvanizing was primarily selected for its, "Long service life to first maintenance and lowest lifetime costs. Other reasons included, competitive first costs, reliability of the hot dip galvanizing process, which in agreement was monitored by the South African Bureau of Standards, speed of application compared to paint coatings, coating toughness, complete coverage of the hollow sections and good resistance to handling damage."

The Storms River Bridge is to many bridge designers and contractors alike, a symbol of bridge construction in South Africa, and it is only fitting that it should continue to play its role for many years to come.

Brief history and factual data

The Storms River Bridge was the first major bridge to be constructed on the section of the N2 from Plettenburg Bay to Port Elizabeth. The design was prepared by an Italian engineer, Dr Ricordo Morandi. The construction of the widening and strengthening of the bridge was carried out in the beginning of January 1986 and was opened on schedule to two-way traffic in time for the December 1986 holidays. The completed project was handed over to the client on 3 February 1987.

The conceptual design method used to widen and strengthen the existing 100m concrete arch was entirely original. The overall width of the deck was increased from 8,180m to 11,450m, using lightweight plate girder cantilever

Photos 1 and 2 – Coating thickness readings on the side (160µm) and top of the handrailings (171µm).

Photos 3 and 4 – Coating thickness readings on guard rail support (154µm) and balustrade transome (210µm) respectively.

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rib supporting the precast concrete slabs to minimize the extra dead weight on the arch rib. The arch rib itself was strengthened by the addition of externally bonded steel plates at the crown and springing, which at the time was thought to be original.

The Storms River Bridge is to many bridge designers and contractors alike, a symbol of bridge construction in South Africa, and it is only fitting that it should continue to play its role for many years to come.

Environmental conditions

The location of the site is approximately within 10 kilometres from the coast and about 130m above sea level. Corrosion conditions are moderate coastal as in C4, according to ISO 9223.

Our findings

In general the coating is in excellent condition and coating thickness readings were all far in excess of the heavy duty coating (105µm) originally requested. See table and photos 1 to 17.

Conclusion

After approximately 18 years of service, the hot dip galvanized coating is providing the maintenance free life, originally specified by the client. Some fasteners, which were originally inadequately protected require coating repair. See photo 18. Should an adequate repair to these minor areas be done, the bridge will continue to provide effective corrosion protection for many, many years to come.

Other specifying requirements of reliable performance and coating toughness, with respect to handling damage have also been provided, as no coating damage could be found.

Photo 5 shows the general view of the "Vastrap Plate" walkway and photo 6 shows the general coating thickness, measured adjacent to the anti-skid ridges (149µm).

Photo 7 shows the close-up appearance of the "Vastrap Plate" and photos 8 and 9 show the coating thickness readings taken on the anti-skid ridges of the "vastrap plate" (11,6 to 140µm).

Photos 10 to 13, indicate how slip joint designs can eliminate the requirement for unnecessary site alterations and consequent coating repair.

Photo 14. In order to avoid the possibility of crevice corrosion at construction joints, organic washers have been introduced.

Photo 15. In order to increase the maintenance free life of the main fasteners, plastic covers were introduced, filled with a silicon sealant and then pressed home. Note the insufficiently coated washer (possibly electro-plated), which is now showing signs of corrosion.

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Photo 16 indicates a fastener that has lost its cover and 17 a damaged plastic cover and rusting washer.

Photo 18. Some fasteners, which were originally inadequately protected require coating repair.

FACTUAL DATA

Height above river	123,48m
Span of arch	91,46m
Rise of arch	20,12m
Overall width of arch	7,93m
Width of road #	6,70m
Length of road	191,46m
Width of footpath	0,6m
Approximate cost of bridge (1956)	R200 000
Cost of widening the bridge (1986)	R2 217 500
Approx. cost of building a new bridge without extra width	R9 000 000

Coating Inspectors Course

Hot dip galvanizing is one of the most widely used methods of protecting steel from corrosion. As a final step in the process, the hot dip galvanized coating is inspected for compliance with the appropriate specifications.

This Coating Inspectors Course has been designed to provide delegates with sufficient knowledge to test, inspect and interpret test results.

Following the course and successful result in a three-part exam, the delegate will be issued with a certificate, and if required, registered as an approved HDGASA inspector. Registration will be confirmed on an annual basis. Successful inspectors will become Individual members of the Association for the year.

The course will be run from the Hot Dip Galvanizer's Association Offices in Kelvin, Sandton. Bookings are limited (maximum 20 people) and will be treated on a first-come-first-serve basis.

COURSE CONTENT

- Introduction to corrosion
- Understanding zinc coatings
- Inspection before hot dip galvanizing
- Inspection after hot dip galvanizing
- Quality assurance in coating applications including report writing

COURSE DURATION

This is a 2-Day Course comprising lectures on the first day, a Plant Tour in the morning of the second day, and the qualifying examination in the afternoon.

DATE AND TIME

Courses commence at 08h00 sharp and end at 16h30, on the following dates: March 8 & 9; April 10 & 11; June 29 & 30 and September 19 & 20.
Lunch and refreshments will be provided. Comprehensive course notes can be collected from our offices two weeks before the course.

COURSE COST AND PAYMENT TERMS

R2 394.00 per person inclusive of VAT. Should you have 2 or more delegates from the same company, course costs will be R2166.00 per person inclusive of VAT. Please note that payment is due on the first day of training. Cheques to be made payable to "Hot Dip Galvanizers Association SA". Members qualify for a discount.

SHOULD YOU BE INTERESTED, KINDLY CONTACT SASKIA SALVATORI AT THE ASSOCIATION.

A group of students completing the test at the end of a recent course.

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