Vol. 6 Issue 2 | 2020

Corrosion Exclusively

INSIDE:

- Using Thermoplastics for Infrastructure Protection – Part 3
- Comprehending Coating Adhesion – Part 2
- NACE & SSPC Merger
- CIVMEC Main Assembly Hall & Frankston Station
- Abrasive Blast Media

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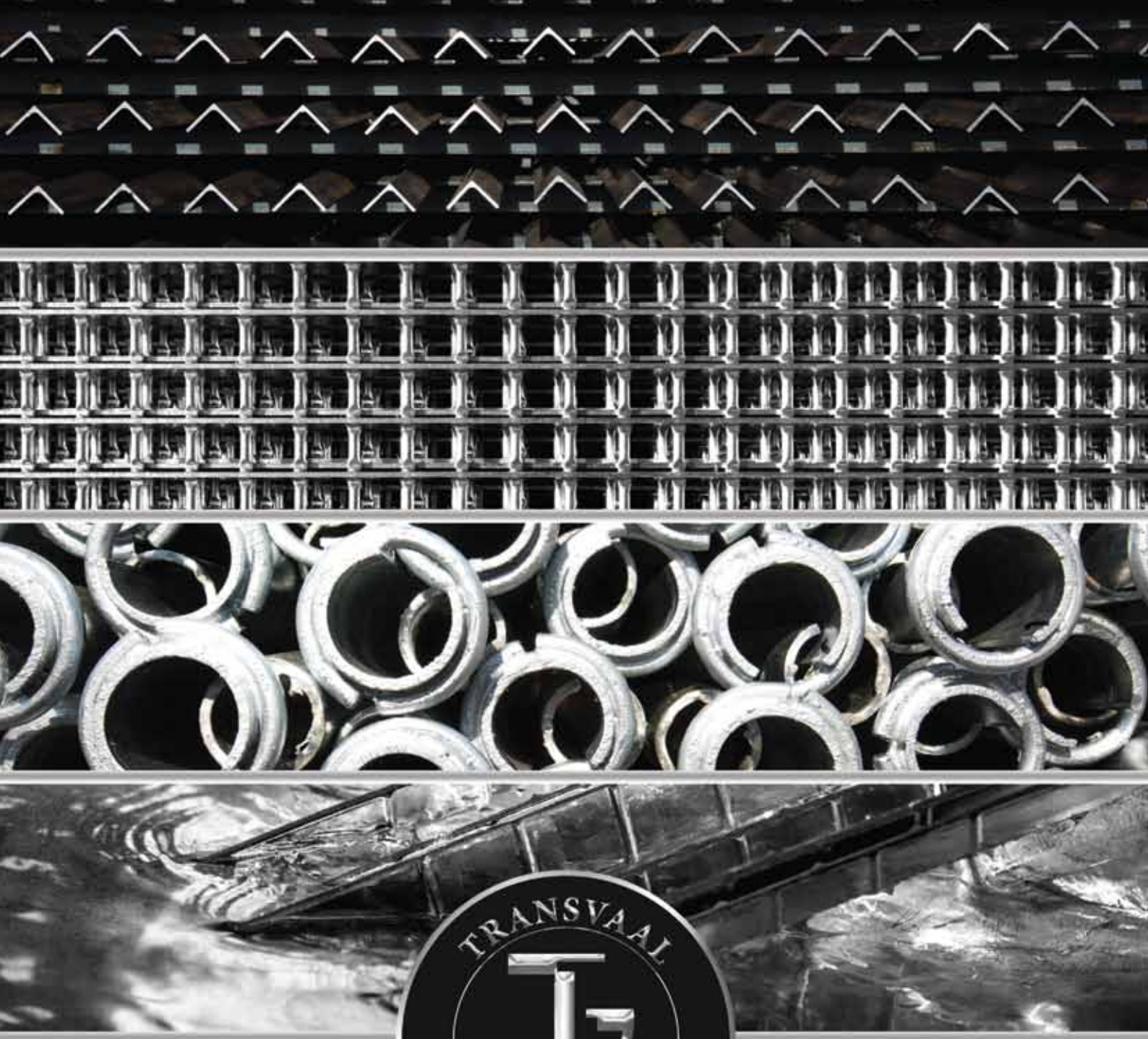

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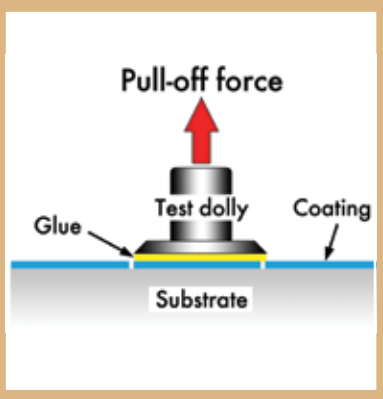

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President's Comment

The world will never be the same. During this current year very few entities and people have come through to this point intime unscathed. For those of you that have lost family members or friends during this period we extend our deepest sympathy and would like to let you know that we feel the pain with you. It has come home to us in that even some of our own staff members have lost people close to them and to them too our hearts go out. In addition to the losses many of us just like me, even contracted COVID-19 but were fortunate by grace to have pulled through and for that too we are thankful.

The lockdown event has also had a very serious impact on the way we lived and on the way that we earn our livelihood. With non-essential services companies having been physically shut for extended periods and with many of their staff based at home trying to keep business alive against great obstacles, many have seen a fall in revenue over the lockdown period. It was a rude awakening for many of us indeed as we struggled to survive under the dominating conditions. However not all resulted in a negative outcome and many of us were forced to slow down and assess how we operated within not only our own lives but also in our places of work and our businesses. This I am sure has in many cases resulted in a new and hopefully better way that businesses will operate going forwards.

Specifically, for CorrISA I am sure all of us would agree that 2020 has been a challenging and tough year. Despite the lack of Technical Presentations and site visits the Corrosion Institute exec and staff have taken the regulated protocols of social distancing, sanitising and where appropriate donning of face masks, continued in the background with items that we feel are high priority namely: Professional Body; Database; Website; and Member Benefits

In addition to the above we have also commenced engaging with government departments, Setas and SOEs with the goal to obtain excellent working relationships, accreditations and constructive engagement and participation with and from them and I am of the belief that great benefit will be derived for our members in the future.

One of the big developments in the last few months has been the appointment of a new director Ms Petra Mitchell. This took place after a stringent screening process and we do think that Petra was the ideal candidate and the right person to make the Corrosion Institute more relevant for all the various individuals and companies that are members and associated with corrosion.

Thanks to hard work behind the scenes by the staff and the lecturers who have resumed NACE courses. Thanks also to all the students who have committed to these courses and we look forward to things returning to a vague semblance of normality next year. In fact, as things stand with the synergy aimed at with us engaging the Government and related entities, I believe that things will be even better going forward.

I take this opportunity to thank everyone that made a positive contribution to helping us to be better going forwards from this Annus Horribalis past. This includes individual members, company members, executive committee members, council members, CorrISA staff members, past presidents with whom we engaged and even some non-members and contractors.

We would like to take this opportunity to wish you all the best for the festive season and to all take a well-earned break and return refreshed for 2021 which promises to be a fantastic year after the challenges of 2020.

Please be safe!

Greg Combrink, President – Corrosion Institute of Southern Africa

OBJECTIVE OF THE MAGAZINE

"The objective of ***'Corrosion Exclusively'*** is to highlight CORRISA activities, raise and debate corrosion related issues, including circumstances where inappropriate material and/or coatings have been incorrectly specified, or have degraded due to excessive service life. Furthermore, it shall ensure that appropriate materials or coatings, be they metallic or otherwise, get equal exposure opportunity to the selected readers, provided these are appropriate for the specified exposure conditions on hand."

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Cover: Our coastal cities and towns have endless examples of failed coatings and corrosion. When are we going to learn? See RUST's a MUST on page 23.

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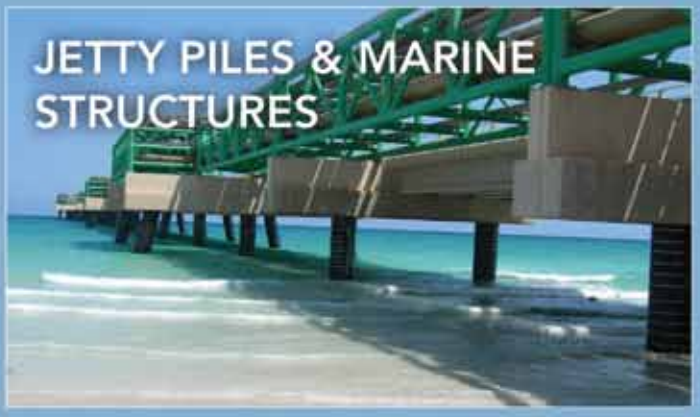

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Editorial Comment

It seems such a long time ago when we produced the first edition just before lock down due to the pandemic. While communication amongst members and readers on the subject of corrosion continued (see "Rust's a Must") it was very different to what we were used to where previously we could chat face to face.

Our thoughts go out to those of our readers who experienced tragedy among family and friends as well as job losses during this difficult time.

Regular technical evenings, general meetings and the CorrISA Awards in Johannesburg and the Gala dinner evening in Cape Town this year sadly had to be cancelled. However, staff at CorrISA have successfully arranged a few virtual presentations and invite anyone who is interested in this activity to please contact CorrISA.

The Corrosion Institute is now 60 years old! It all started when a group of corrosion enthusiasts got together in 1960 (*see Vol 1 Issue 1)*.

In this edition we include several articles addressing practical methods of corrosion control, including:

- Using thermoplastics for structures – Part 3.
- Comprehending coating adhesion – Part 2. To stick or not to stick.
- NACE and SSPC merger on the cards.
- CIVMEC Main Assembly hall and Frankston Station, two hot dip galvanized projects from the GAA.

From the KETTLE, a regular contribution on hot dip galvanizing we discuss surface conditions F30 (Solidified zinc traps) and F31 (Ensure the component is structurally sound).

We interview and welcome the newly appointed Executive Director Petra Mitchell, who takes over this all ladies team and thank Linda Hinrichen who is generally responsible for arranging the NACE Courses but in the interim since the last incumbent left, successfully acted as Manager in charge.

Graham Duk the Western Cape chairmen gives an account of the Cape Region and the Vice Chairman Marco Ashburner the KZN activities.

We report on a recent get together by the Cape Town committee at the premises of Emplast where John Houston entertained all around his braai and pub area of his factory.

Under Education we include two educational course's Corrosion Engineering and NACE CIP 1 that took place in September and November respectively.

The "RUST Spot" features Prof Denis Twigg who consulted and lectured during his active years travelling between the UK and South Africa and now at 85 years young has decided to hang up his boots in the United Kingdom.

We say goodbye to a friend and colleague Bob Andrew who passed away on the 10th of October and with whom my old colleague at the HDGASA, Walter Barnett and Mike Brett successfully introduced hot dip galvanizing to the mining industry.

We wish to sincerely thank all our advertisers who under extremely trying financial circumstances continue to support the publication. It is again through the support of people and companies like yourselves that this publication will eventually be considered a "must read" magazine amongst all Southern African specifiers when requiring an effective corrosion control method.

We also wish to thank our amazing contributors, who painstakingly continue to offer us technical articles of extreme value.

Lastly, we wish all our members, advertisers, contributors and readers a happy, safe and healthy festive season and look forward to compiling the next magazine early in 2021.

Terry Smith

Using thermoplastics for infrastructure protection in marine and other challenging environments

Prepared by A&E Communications & Technical Department for Australasian Corrosion Association (ACA)
Presented by Sean Ong (General Manager, Asia) at Corrosion & Preventions 2017 Conference, Sydney, Australia

PART 3 (OF 3)

Real world examples

In the fifteen years since the first introduction of CIST there has been a wide range of applications in a variety of industries, particularly in the Offshore, Mining, Gas and Power Generation industries. We have already seen the results for application results for a major oil company on one of its unmanned platforms in the North Sea, but these images are from other platforms in the area, where CIST applications were first introduced in 2003.

First applications were introduced to remedy potential bolt failure on small flanges but soon spread to include a range of other substrates. Particularly vulnerable are carbon-steel bolts in stainless steel joints as *Figure 22* shows. Significantly, seven years after receiving CIST protection, similar substrates in the North Sea were uncovered for maintenance purposes and no corrosion was found to have taken place.

In 2008, a platform that had significant corrosion even before it was commissioned, had more than 8 000 flanges coated to stabilize rust across the structure.

Experience on these platforms has led to successful applications on offshore facilities from California to the Congo for Total, Nobel, ConocoPhillips, Shell and a number of smaller companies.

Australia

CIST is scheduled to be used on offshore facilities in Australia for the first time this year but Australia was one of the first places to recognize the value of CIST, introducing standby protection for the mining industry in 2000. Although most mining in Australia takes place a long way from the sea, it all ends up in ships and is often transported using long conveyor systems which are very exposed to environmental conditions.

These two conveyor bearings illustrate both the problem and the solution. *Figure 26* is from a salt conveyor in Port Hedland. Bearings on these conveyors were failing in as little as nine months from exposure to highly saline water and contaminants from the transport of mineral salt. Following the success of CIST for standby protection, trials were undertaken for the introduction of CIST protection

Figure 22: Failing carbon steel bolts in stainless flanges.

Figure 23: Mixed carbon and stainless substrate after 7 years.

Figure 24: More than 8 000 flanges coated.

Figure 25: A group of small coated flanges.

Figure 26: Severe rusting from high salt levels.

Figure 27: No corrosion on test bearing.

Figure 28: After 12 years.

Figure 29: 12 years with CIST and 12 years without.

Figure 30: CIST coated bolts on a wind turbine tower.

on live bearings. *Figure 27* shows removal of material from test application revealing perfectly preserved substrate.

The trials were an immediate success, bearings protected with CIST continued to perform without any deterioration for more than 4 years. Data collected for BHP Billiton and Rio Tinto in 2005 showed a 500% increase in equipment lifespans and a significant reduction in accidents because of the reduced maintenance requirements. CIST is now used across the mining industry in Australia for conveyor and standby protection.

Recently, an engineer who was a pioneer for CIST in Australia, sent us photos of applications his company had made up to 12 years earlier. Following removal, the substrates were found to be in excellent condition despite having had no attention whatsoever in the intervening years. He was ecstatic.

Conclusion

Many other applications in other industries have benefited from the unique qualities of CIST. In the US, results from applications in the mining industry have duplicated the savings and bearing replacement reductions found in Australia, with applications to underground conveyors in Canadian potash mines commencing in June this year. Gas production in Oman, high voltage switchgear in the UK and Europe, bolt protection on wind-turbine towers in the US and Europe – the range of applications has been enormous.

Nothing is perfect, but the results seem to show that CIST has some very effective answers for corrosion and ingress problems in marine and other challenging environments – particularly on complex and vulnerable assemblies where standard coating systems cannot be used.

Figure 31: CIST being applied on to high voltage switchgear in the UK.

The Editor wishes to thank the Australian Corrosion Association and Sally Wood (sally@wordly.com.au) for this article which was previously printed in "Corrosion & Materials".

Comprehending coating adhesion: pull-off adhesion testing

By Rob Francis, R A Francis Consulting Services, Ashburton, Victoria, Australia.

PART 2 (OF 2)

Summary

Pull-off adhesion testing is often specified and used to quantify adhesion of coatings to substrates or within a coating system. There are a number of commercial devices available for this purpose. However, investigation of the methods used shows that the devices can give significantly different results and are subject to substantial levels of error. Furthermore, failure is often cohesive within a coating and the result gives no indication of coating adhesion. This paper looks at pull-off testing devices, results obtained and provides guidelines to evaluate their meaning and significance.

Keywords: *Coatings, adhesion, pull-off testing, cohesion.*

Introduction

Pull-off 'adhesion' testing of coatings appears to be more regularly discussed and specified in recent years. Manufacturers have produced new testing models, more papers are being published on the subject and pull-off requirements are increasingly being required in coating specifications. Is this increased interest based on its ability to provide useful information on performance of coating systems, or is this a case of a test method being more attractive because it can produce a number, even if that number has little meaning? This paper looks closely at pull-off testing, what is measured and what the results mean.

Principles of pull-off testing

Common perception is that the "adhesion strength" as determined using a pull-off tester is a measure of how tightly the coating layers adhere to the substrate or between one another. In fact, the majority of figures obtained from such testing and the actual failure path show that adhesion strength is not being measured but rather some other property independent of the level of bonding between various interfaces. To properly interpret the results, it is necessary to have an understanding of how pull-off testing is actually carried out.

For such testing, a portable adhesion tester, commonly called a pull-off tester is used, usually to standards such as ASTM D4541[1], AS 3894.9[2] or ISO 4624[3]. ISO 16276-1[4] also covers such testing, but refers to the measurement of "fracture strength", which includes both adhesion and cohesion failure. Unlike ISO 4624, this standard covers testing on site, with instructions for interpretation of results and acceptance / rejection criteria. In all cases, the test method consists of securing a loading fixture (commonly called a dolly) to the coating surface with an adhesive (glue) as shown in *Figure 1*. The testing apparatus is then affixed to the dolly and aligned to pull the loading fixture perpendicular to the coating surface. The force is gradually increased until the loading fixture detaches, which will be that at the weakest interface. The user ideally then reports not only the pull-off strength, but also the location of the break in the coating system, i.e. adhesion failure between the primer and substrate or between coats, cohesive within a certain coating layer, glue failure, etc.

Practical pull-off testing

There are a number of devices on the market which use this principle for carrying out such tests, but there are differences between them which can significantly affect results. In some models, the load is applied by compressing a spring (mechanical), while in others the load is applied pneumatically or hydraulically. In earlier models, the grip for engaging the dolly is fixed, while in later models it can move, ensuring alignment is more perpendicular to the load. Because of these differences, the pull-off gauges available do not give comparable results. ASTM D4541 recognises this and divides them into different types, each with its own test method, as shown in *Table 1*. Type I gauges are generally used for concrete and were dropped from the standard in 2004, although results from this device can be found in the literature.

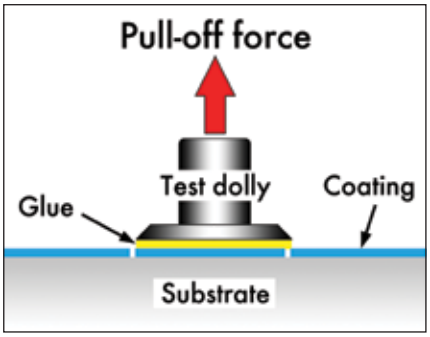

Figure 1: Pull-off adhesion test.

In the 2009 version of ASTM D4541, the pull-off strength of four painted panels was determined using five devices in a round-

ASTM D4541 Type	Test method	Example	Load mechanism	Dolly alignment	Repeatability Limit (%)	Reproducibility Limit (%)
Type I	A	Dyna Z5	Mechanical	Fixed		
Type II	B	Elcometer 106	Mechanical	Fixed	64.7	76.0
Type III	C	HATE, Elcometer 108	Hydraulic	Self-aligning	33.8	65.9
Type IV	D	PATTI	Pneumatic	Self-aligning	14.8	28.4
Type V	E	Positest AT	Hydraulic	Self-aligning	27.8	34.1
Type VI	F	PAT Handy, PAT GM03	Hydraulic	Self-aligning	17.5	23.0

Table 1: Pull-off adhesion testing devices according to ASTM D4541.

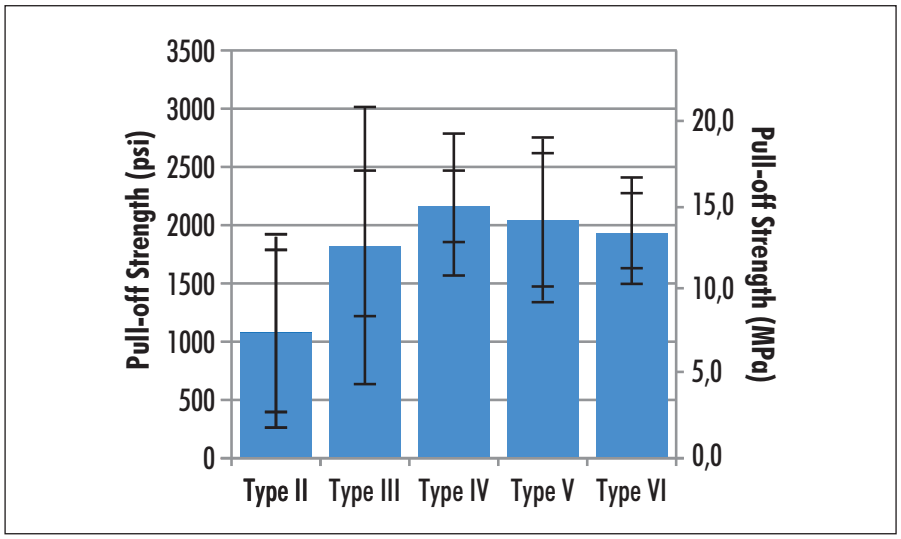

Figure 2: Pull-off results for test panels and repeatability and reproducibility limits for five pull-off testing methods from Tables 1 to 5 in ASTM D4541-2009.

robin survey. Average readings with each type are given in *Figure 2*. The repeatability and reproducibility limits in *Table 1* give the maximum acceptable percentage difference between results before they should be considered significant; repeatability for a single operator with a single device and reproducibility between different operators. These are also plotted as error bars on *Figure 2*, with the repeatability limits the lesser values. These high figures indicate that test results are subject to considerable uncertainty, an issue also discussed by Schilling[5]. For example, if one operator gets a result of 7MPa with a Type II gauge under certain conditions, then a second result under different conditions needs to be less than (7-(7 x .65)=) 2.5 MPa or more than (7+(7 x .65)=) 11.6 MPa for the change to be considered as significant. Even the most repeatable gauge, the Type IV, would need results outside the range of 6 to 8 MPa to be considered significant. When comparing results to those obtained by other operators, the expected spread of results will be even greater. Clearly, small differences in pull-off values within or between investigations, especially higher values, should not be considered as significant.

The Type II fixed alignment gauge appears to give greater variability than the self-aligning gauges so the scatter is probably due to higher probability of shear forces operating with the fixed alignment gauge. The variability obtained with the Type III gauge, although self-aligning, may be due to the different loading mechanism through the centre of the testing dolly which again may introduce shear stresses. Cunningham and Steele[6] also found that fixed alignment gauges tend to create variable results with more 'scatter' around the mean result than self-aligning gauges.

Some of the reasons for the varying results include misalignment of the apparatus or loading fixture so that it was not perpendicular to the surface, variation of the area stressed due to improper application of the glue, holidays in the glue caused by voids or inclusions, improperly prepared surfaces, and sliding or twisting of the test fixture during the initial glue curing. It should be noted that it is very difficult to apply a perfectly axially-centric load, even with self-aligning grips. Other factors are glue runs underneath the loading fixture on vertical surfaces and knocking the loading fixture off prior to or during the attachment of the test apparatus. Almost anything that can go wrong in performing the test will give low results, not higher results. Experienced field users find that five to ten percent of pulls end up being invalid. Therefore, applying at least three test fixtures per location in the field is a must when performing this test.

As well as differences in repeatability and reproducibility, different gauges give different values of pull-off strength for the same test coating and panel. The round robin survey quoted in the 2009 version of D4541 and plotted in *Figure 2* shows that Type III, Type IV, Type V and Type VI instruments give comparable results, definitely within the uncertainty discussed above. However, the popular Type II instruments give pull-off strengths of about half that of the other instruments. It is clearly critical to identify the instrument that is used in any investigation.

An investigation of a number of pull-off test methods[7] confirmed that the Type II Elcometer Model 106 gave considerably lower figures than pneumatic or hydraulic methods. Cunningham and Steele[6] also noted instruments based on hydraulics appear to achieve higher results than mechanical (spring) devices, probably because the application of force was smoother in the case of hydraulic instruments. They described an experiment where a mechanical tester was modified by removing the spring and replacing it with hydraulics operated by an electric pump. The average results were twice those previously obtained. The significant factor appears to be the smoothness of force application rather than the absence of self-alignment. These finding suggest that values obtained from a Type II unit need to be doubled when compared to results from one of the other types of gauges.

What does the pull-off test actually measure?

The pull-off test does not measure adhesion. It can be viewed as a simplified tensile test which measures fracture strength of the weakest bond in the substrate/ coating/ glue/dolly system. If the fracture is between layers, the strength determined will be a measure of adhesion, but if fracture is within a coating, then the result will be a measure of the coating's tensile strength. However, the tensile strength as determined from the pull-off test will not be the same as that determined using tensile testing instrumentation for a number of reasons. For example, for some polymers the rapid loading (strain) rate of manual pull-off testing will result in a increased strength measurement. (Ductility decreases and modulus increases also but these cannot be determined by pull-off testing, only the ultimate tensile strength). The sensitivity of polymers to strain rate depends on the type of polymer: for brittle polymers the effect is relatively small, whereas for rigid, ductile polymers and elastomers, the effects can be quite substantial if the strain rate covers several decades. For other polymers, rapid loading can decrease strength, especially of cracks and other defects are present and failure changes from ductile to brittle. However, it is the nature and design of the test sample that will result in the greatest variation. Standard tensile testing uses a dogbone-shaped sample where the stress is restricted to run parallel to the applied force along the central part of the sample and there is no significant stress concentration at the ends of the sample altering stress

distribution. The stress distribution across the plug of coating in pull-off testing is not uniform unlike the dogbone-shaped specimen, with stress concentration at the edge giving higher localised stresses resulting in considerable variation and scatter in results, as well as lower strength figures.

Much published work quotes the results of pull-off tests, claiming that they are values of 'coating adhesion' without noting the location of the failure[8] or combining and comparing results at any failure location, whether adhesion, cohesion, within the glue or some combination[9] without distinguishing between the meaning of the results. The pull-off value for a cohesion failure will not give any indication of the adhesion properties of the coating; it will only give some measure of the tensile strength of the coating where the failure occurs. Yet a number of papers claim to investigate the effects of various parameters on coating adhesion by quoting these pull-off cohesion failure strengths. Even the results of work that looks at comparisons, say before and after weathering, indicate nothing about adhesion strength if the failure is not an adhesion failure.

A further issue in analysing results from pull-off testing is that it is unlikely to correlate to the long term corrosion protection offered by a coating. There is no doubt that coatings must adhere well in order to resist the advance of water and other aggressive species across the coating surface, but there is no indication that high pull-off values will provide improved corrosion protection[10]. A slow-curing coating may show poor initial adhesion or cohesion, but these properties may rapidly improve. Alternatively, a coating may show good initial adhesion but moisture penetration may cause corrosion at the interface leading to rapid reduction in adhesion. Pull-of strength measured soon after application will rarely provide an indication of longer term performance.

Pull-off test results

Despite these concerns, there are a large number of reports and papers presenting the results of pull-off testing and useful information can be obtained from such work detailed below. From the above discussion, useful conclusions can really only be obtained from work that clearly identifies testing unit used and the location of fracture. Furthermore, triplicate or better testing should have been carried out for useful results. Results without such information are of little value.

Effect of the substrate

The substrate can be an important consideration. Testing an epoxy, for example, applied to concrete will usually fail in the concrete, but the same epoxy over steel will fail in the epoxy, assuming there is no weaker interface. O'Dea et al[11] investigated various pull-off testing methods and standards for concrete. For such work, the dolly diameter is usually much greater, 50mm or more. There are different standards for testing, and often different testing units are used so results cannot be compared with the other work discussed in this paper which covers steel substrates. Of interest were the results from different testers using different methods, but all gave low values of 1.4 to 3.4 MPa as the concrete substrate is typically the region where failure arises. The fixed alignment unit gave lower figures, but not always.

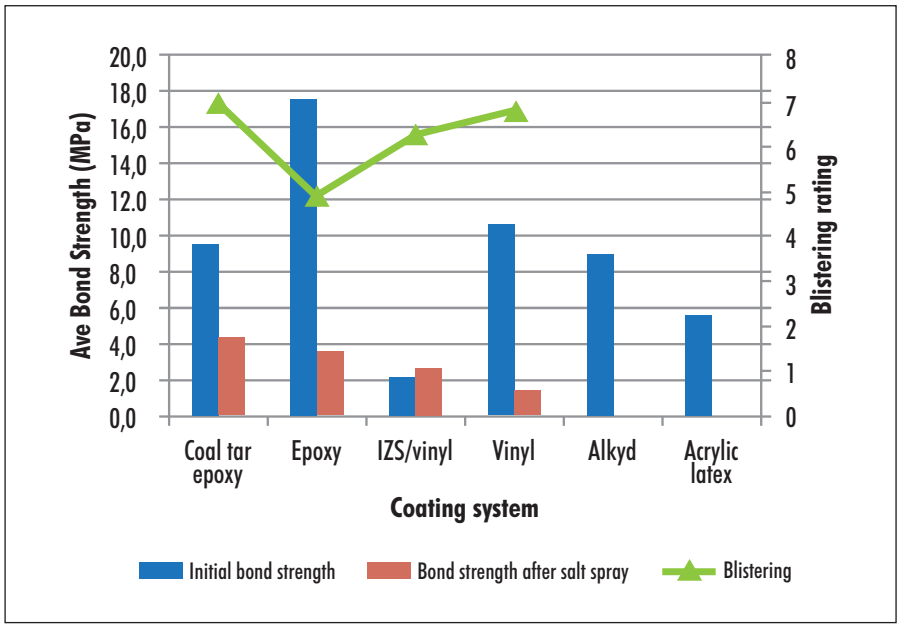

Figure 3: Pull-off strength and blistering as a function of coating system before and after salt fog exposure.

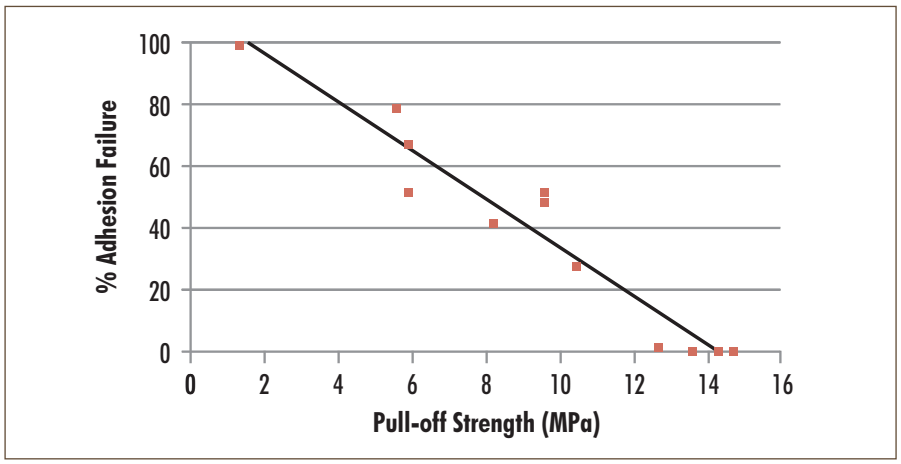

Figure 4: Relationship between pull-off strength and % adhesion failure for one investigation[18].

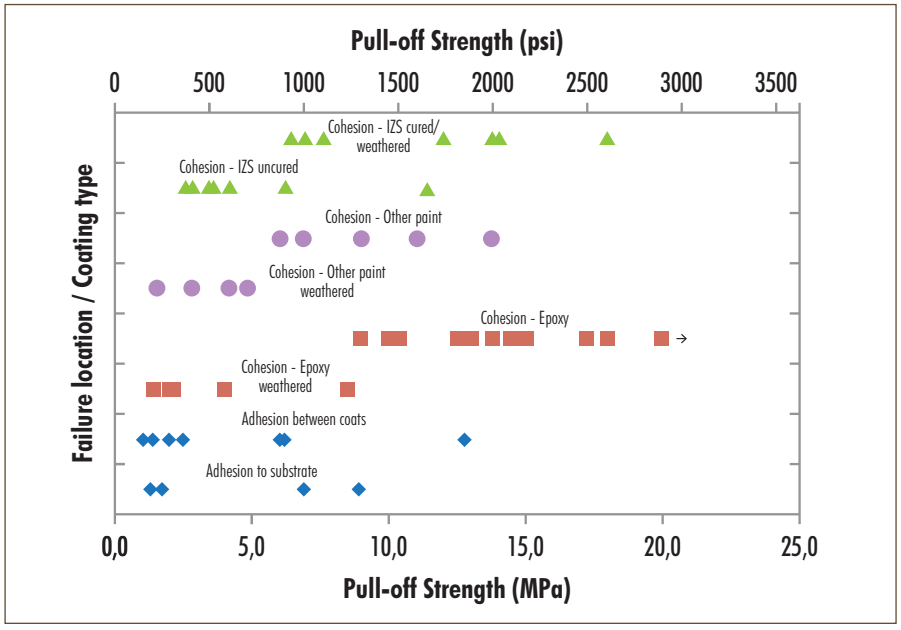

Figure 5: Summary of pull-off strength results for different failure locations and coating types.

Cutting around dolly

Before looking at typical results, it is worth looking at the influence of cutting around the dolly, a factor often considered important. Some have said this has no effect[12], others have shown it only has an effect with thicker coatings[6] while Baek et al noted an effect only with thin coatings[8], although the effect was minor. ISO 4624 claims it can have "a big influence in the adhesion of the paint system" (clause 5.4 in 2002 version). ASTM D4541 states that "Scoring around the fixture violates the fundamental in-situ test criterion that an unaltered coating be tested" with the additional comment in the 2009 version that "Scoring is only recommended for thicker films, that is thicknesses greater than 500 microns, reinforced coatings and elastomeric coatings". Fletcher and Barnes[13] investigated the effect of a number of variables on pull-off results. With 15 investigations using a Type V tester and results varying from 8.5 to 10.6 MPa (failure in the coating or glue or both), little effect of cutting could be determined. Unfortunately the type of coating and its thickness were not given with this work. It is most likely that the effect of scoring is often absorbed by the uncertainty noted above, but may be important in thicker coatings.

Glue failure

Clearly the glue should have a greater cohesive or adhesive strength than the coating being investigated, but fractures within the glue have been reported. Different glues will have different strengths which could influence results. Standard two-part epoxies are considered to have highest strength, with cyanoacrylates somewhat lower. A number of investigations have shown that both give high strengths greater than 10 MPa (with Type III or Type V devices). Fast drying epoxies have been found to have the lowest strength (around 5 MPa) with similar test units. Zhang and Myers[9] used a standard epoxy glue and the maximum pull-off strength (coating cohesion failure) reported was 18.6 MPa, indicating glue strength must be greater than this figure. Nilsen and Scheie[7] tested a number of cyanoacrylate glues using a PATTI (Type IV) device, reporting pull-off strengths above 25 MPa. Fletcher and Barnes[13], using a Type V device compared two glues provided with test kits (assumed to be epoxies) and both gave pull-off strengths of about 10 MPa. The authors noted "the crucial factor is that [they] have sufficient strength to carry out a successful adhesion test" which should not

be a problem, unless perhaps fast drying epoxies are used. Another issue with the glue is that it is important that it does not modify coating properties, although this has not been reported.

Coating (cohesion) strength before and after weathering

Biddle[14] found that the Type II pull off strength of uncured or partially cured inorganic zinc primer under an epoxy gave cohesion failure values of 1.5 to 2 MPa with failure in the primer, increasing to 3.2 MPa or higher for cured IZS primer, with the break occurring in the epoxy film.

Schwab and Drisko[12] applied a number of coating systems to blast cleaned panels and measured the pull-off strength using a modified tensile testing machine which, due to the slow and steady load application, would give results similar to or higher than a self-aligning hydraulic or pneumatic unit. They exposed the panels to 8 000 plus hours in a salt fog cabinet and measured the pull-off strength again. They also assessed the degree of coating breakdown as a blistering rating from 1 to 10 (10: best, 0: worst) after exposure to salt spray. *Figure 3* shows the initial coating fracture strength for epoxy, vinyl, alkyd and acrylic latex ranges from 6 to 18 MPa, but a much lower figure was obtained for the inorganic zinc silicate (IZS)/ vinyl system, which adhesively failed at the primer/ top coat interface. The alkyd and acrylic latex systems failed early during accelerated testing and were removed from the test. After salt fog exposure, pull-off strength dropped considerably for three of the remaining systems, but increased slightly for the inorganic zinc/ vinyl system. There was no relationship between pull-off strength (either before or after weathering) and degree of blistering. This work gives an indication of the fracture strength of a number of coating types and shows that, apart from IZS, weathering causes a significant drop in strength.

Similar results were reported by Zheng and Myers[15], who carried out a large number of pull-off tests (ASTM D4541 Type V testing unit) on a range of coating systems before and after accelerated testing (freeze-thaw and salt spray). Thick (0.5 to 1mm) polyurea systems showed good initial strength of around 13.8 MPa, failing by cohesion within the thick topcoat. On salt spray exposure, pull-off strength dropped to 2.8 to 4.1 MPa, with adhesion failure between substrate and primer. Despite the thick topcoat, corrosive spray had penetrated to the primer/ substrate interface and caused the primer to lose adhesion.

Baek et al[8] carried out pull-off 'adhesion' testing but reported no adhesion failures, so was in effect using the method to determine fracture strength of coatings. They used a Type IV pneumatic instrument (PATTI) with 13mm dollies on a polyamine epoxy. They found that tensile strength increased slightly from around 12.5 to 14.5 MPa with curing from 7 to 56 days at 23°C. The samples were cured in air for four weeks then soaked in water for 14 days at 50°C. Pull-off strength dropped to around 8.5MPa immediately after soaking, but recovered to around 13MPa after about 800 hours of drying.

Bajat and Dedic[16] determined the adhesion of epoxy primers using a Type II tester. They did not record failure locus, but it appears to be cohesion failure. The zinc rich epoxy gave a pull-off strength of 7.5 MPa, a zinc chromate epoxy 5 MPa and a non-inhibitive epoxy primer 4.5 MPa. They measured adhesion after water soaking and recorded a reduction in coating strength with water saturation of the coating, dropping to 1 to 2 MPa for all three coatings. They did not record a change in failure mode, so it is assumed to still fail cohesively. Figures twice these would be expected with other testing units.

Curran[17] investigated pull-off strength when looking at polysiloxane alternatives to polyurethane systems used at NASA Kennedy Space Center. Testing was carried out to ASTM D4541, but the test unit type was not given although it appears to be hydraulic. As part of the investigation, adhesion of the IZS primer was investigated, with pull-off values of 2.8 to 6.2 MPa for a range of commercial solvent-borne inorganic zinc primers, failing cohesively. Interestingly, adhesion was tested after heating to 400°C for 24 hours, for coatings used in regions of rocket exhaust. Post-heat adhesion increased significantly to 11.6 to 17.9 MPa as a result of continued curing of this type of coating. Adhesion testing of the candidate topcoats showed a range of pull-off strengths and failure modes, but where failure occurred cohesively in the IZS primer,

values of 12.4 to 14.5 MPa were observed, indicating the primer was thoroughly cured before topcoating.

These results suggest that cohesion strength of epoxy coatings, using a hydraulic or pneumatic tests should be at least 10 MPa, although other workers have quoted figures two or three times this. Other coatings will probably have slightly lower cohesive strength. Improperly cured inorganic zinc will show low cohesive strength (usually less than 5 MPa) but will increase on curing and weathering. Other generic types will show a marked reduction in cohesive strength on weathering or water soaking.

Adhesion strength

Very few pull-off investigations actually quote true adhesion strength. Most failures, such as detailed above, are cohesive. One useful investigation was that of Islam et al[18] who looked at the effect of different methods of surface preparation on the pull-off strength of chopped strand mat impregnated epoxy resin applied to steel. Pull-off tests were carried out to ASTM D4541 and, although the type of tester is not mentioned, it appears to be a Positest (Type V) model. The authors found a relationship between the percentage adhesion failure and the pull-off strength (*Figure 4*). For a purely cohesive (resin) failure, pull-off strength was around 14 MPa, and for a purely adhesive failure, the strength dropped to just over 1 MPa. The pull-off strength increases as the failure becomes more cohesive. It would appear that, if the failure is more than a few per cent cohesive, then the pull-off strength will noticeably increase.

Bilotta et al[19] carried out adhesion tests on intumescent coatings using a Type IV tester and found low adhesion between the primer and intumescent coat. The thickness of the intumescent coat had some influence, with pull-off values of 4 to 8 MPa for coatings of around 500 microns, but down to 1 MPa when the intumescent coat was applied at 1 500 microns.

Higher values for adhesion are uncommon, but have been reported. For example, Curran[17] reported two results which showed adhesion failure between the mid and topcoat, with relatively low values of about 6.2 MPa, but two similar adhesion failures gave pull-off strengths of 11.7 MPa and 13.8 MPa, significantly higher pull-off adhesion values than appear to have been recorded elsewhere. Yang[20] investigated adhesion of coatings to galvanized surfaces using, it would appear, a Type V testing unit. There were a number of largely adhesion failures between the epoxy intermediate and galvanized surfaces resulting in pull-off strengths of 4.1 to 13.8 MPa for epoxy/ polyurethane systems applied to 'mechanically-prepared' galvanizing, which appears to have been prepared with a fine disc sander. For whip blasted galvanizing, adhesion failures between the primer and the zinc were not observed, with all failures cohesion or adhesion between one of the other layers, and pull-off figures of 10.3 to 17.2 MPa.

It would appear that 'poor' adhesion gives pull-off strengths of approximately 1 to 5 MPa, but there may be rare cases where there is an 'adhesion' failure at values expected for cohesion or glue failures, which will signify 'good' adhesion.

Summary

Figure 5 combines many of the above results (along with some others) to show the range of failure modes and pull-off strengths that may be observed. These can be divided into a number of alternatives. Substrate and glue failures have not been considered, and the strength values are those obtained with hydraulic or pneumatic testing units. Pull-off values obtained with a mechanical (Type II) unit would be about half those noted.

1. True adhesion failures may be between the first coat and substrate or between coats. If adhesion is poor, pull-off values of less than approximately 3.5 MPa will typically be observed, usually much less than this. 'Good' adhesion will show values of double this, usually more.

2. Whether an adhesion value of 3.5MPa or less is a problem depends on the situation. If the coating is exposed to the atmosphere, then it is unlikely to be subject to significant tensile stresses and there are unlikely to be problems. However, if the coating is subject to tensile stresses, then poor adhesion could be a problem. For example, if the coating is to be overcoated with a product with high shrinkage stresses, such as some epoxies, then it may lift. Low adhesion values should be considered when selecting maintenance paint systems.

3. The values obtained for cohesion failures are an indication of the tensile strength of the coating, and provide no information on adhesion strength, other than observing it must be greater than the value obtained. Sound epoxies will give pull-off values of at least 10 MPa, but values of two or three times this may be observed. Other generic types (other than inorganic zinc, see below) may be slightly weaker.

4. Weathered or water-saturated coatings will fail cohesively or adhesively at lower pull-off values, usually between 1 and 10 MPa depending on how degraded the coating has become.

5. Insufficiently cured inorganic zinc silicate will fail cohesively at low pull-off values of approximately 1 to 5 MPa, depending on the extent of curing. Properly cured or weathered IZS will fracture at increasing greater pull-off values as the coating cures and hardens.

Conclusions

Pull-off testing is commonly specified or used to quantify the adhesion of coatings to substrates, or adhesion between coats. However, close investigation of the methods used, and published results, show that it does have a number of weaknesses which limit its value. These findings can be considered as the 'Terms and Conditions' for those carrying out pull-off testing and include:

a) There are a number of commercial devices available, but results can differ significantly between them. For example, the mechanical, spring-operated device will give pull-off values about half that of pneumatic or hydraulic types.

b) The relatively poor repeatability and reproducibility of the test methods makes obtaining and interpreting meaningful results difficult.

c) There is no convincing evidence that such results provide any indication of long-term coating performance.

d) Most failures will be cohesion within the coating, which is a measure of coating tensile strength, but does not relate at all to coating adhesion.

e) An adhesion failure at a relatively low pull-off strength (<3.5 MPa) is an indicator of poor coating adhesion. However, low pull-off strength is unlikely to be an issue, except when selecting coatings for overcoating and repair.

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The Editor wishes to thank the Australian Corrosion Association for this article which was previously printed in "Corrosion & Materials".

NACE and SSPC announce Robert H. Chalker as Chief Executive Officer of new, combined organisation

NACE International and SSPC: The Society for Protective Coatings have announced that Robert H. Chalker has been named chief executive officer (CEO) of the new, combined organization that was approved by ballot of both NACE and SSPC membership bodies in April. Bill Worms, who has served as executive director of SSPC since 2015, will remain at the helm of SSPC while the process of combining the organizations begins. The staff and office facilities of SSPC will remain in Pittsburgh, Pennsylvania, USA.

Chalker has nearly 20 years of association management experience and has served as CEO of NACE International since 2010. Prior to joining NACE, he was the managing director of ASQ Global where he was responsible for developing a global network of quality professionals and experts focused on educating the world on the principles of quality. Chalker also served as director of Global Development and Strategic Planning for the Society of Automotive Engineers (SAE International).

"Bob's association experience is tailor-made for this transition," says Terry Greenfield, now immediate past president of NACE International. "Bob's extensive background in management and organizational leadership has resulted in a culture of high performance and success for NACE. That will be a tremendous asset as the leaders of both organizations work to strategize and develop a single organization that will serve the world's corrosion and coatings professionals at every level of expertise."

Adds Joseph Walker, president of SSPC, "I have known Bob since he took over as CEO of NACE and have worked with him in my role as a member of the NACE Education Committee. I have always been impressed with his leadership approach and his vision for the future. He builds great teams and has in-depth knowledge of the coatings and corrosion industries. I look forward to working with him as we bring the organizations together."

"I'm honored to lead these two venerated organizations through this monumental change," says Chalker. "This is an opportunity to provide coatings and corrosion professionals worldwide with more mission-driven value, making societies safer by strengthening the standards, education, and certification programs that make our members the best at what they do."

Referencing Worms, Greenfield states, "Bill has achieved extraordinary work at SSPC. He is highly respected by members, staff, and industry and has been an outstanding partner in the years we've worked together on mutual efforts on behalf of the organizations, and again throughout this process of considering combining NACE and SSPC."

"In just five years, Bill has managed to build a legacy that will be foundational to success of the new organization," says Chalker. "What Bill has done on behalf of SSPC's members and the coatings profession has elevated the value of SSPC programs, and strengthened safety, environmental, and economic benefits afforded to industry through those important programs.

"In its 70-year history, SSPC has only had five executive directors. Not many people realize that," adds Walker. "Bill came to SSPC in 2015 not only with the reputation as a steady leader, but also as someone who could take SSPC to the next level. His performance as an executive did not disappoint. He's been aggressive in expanding SSPC's global footprint and pushing the organization to new heights of success. Without that kind of growth, I don't think we would be talking about combining organizations right now. Bill's leadership has been that impactful and a true testament to his capabilities."

"I've been honored to lead SSPC over the past five years," says Worms. "It was a new challenge for me coming from the corporate world, but it has been very fulfilling. At the start I set out to recruit a talented staff and set some aggressive growth goals for the organization. Our team really responded to the challenge, increasing engagement with members, opening up new markets and new opportunities, and making SSPC a one-stop-shop for coatings industry professionals looking for training and technical resources." Worms continues, "I'm looking forward to working with Bob and the transition team to help the new organization take shape." Currently, leaders of SSPC and NACE are planning on a January 4, 2021 debut for the new association. Worms is expected to remain at SSPC through the end of 2020.

Chalker earned his MBA at Oakland University (Rochester, Michigan, USA) and completed his undergraduate studies at the University of Cincinnati, where he received a bachelor's degree in industrial engineering. He also sits on the boards of the Katy Area Economic Development Council and Council of Engineering and Scientific Society Executives (CESSE) and is a member of Texas A&M Engineering Experiment Station's Industry Advisory Board.

VIRTUAL PRESENTATIONS

HDGASA

On the 16th October, we were delighted to have Mr Anthony Botha from the Hot Dip Galvanizers Association of South Africa as our first virtual technical presentation presenter. Members and subscribers got a chance to learn more about his interesting topic titled "Preparation of Hot Dip Galvanizing for Duplex Coating".

GAMRY INSTRUMENTS

Another exciting topic by Gamry Instruments was presented by Dr Jacob Ketter titled "EIS for Corrosion and Coatings" on the 22nd October.

Ecoblast® blasting abrasive – a first for South Africa

Ecoblast® is an expendable abrasive, a product resulting from 12 years of research and development from a ferrochrome slag resource previously discarded as having limited value in the abrasives industry.

Ferrochrome slag is an abundant resource as a "by product" of ferrochrome production, a major industry in South Africa, a country which holds approximately 80% of the world's known chrome reserves, destined for the manufacture of stainless steels.

Unlike granulated copper or platinum slags, previously available for processing as expendable abrasives in South Africa, ferrochrome slags are neither simple or necessarily suitable for processing into usable abrasive products. The by product requires extensive processing and treatment.

Ecoworks Industrial Products Pty Ltd (Ecoblast®), in conjunction with Afrigrit in Witbank, has developed a unique process that economically optimises a ferrochrome slag by product which not only produces an environmentally approved aggregate for road building but, through further complex processing steps have produced a globally approved abrasive, that is taking the world by storm.

Ecoblast® performance in practice, has impressed markets around the world and has been dubbed as "synthetic" garnet by some, probably because chemically and physically, it has many of the same features of garnet which, internationally is the "darling" favoured abrasive by most companies.

Standards governing corrosion protection specifications globally have become increasingly stringent and the requirements around abrasive supply have not gone unnoticed. Alluvially sourced garnets are burdened by the fact they are sourced from beach deposits and, understandably, it is difficult to rid the product from inherent salt contamination. However, Ecoblast® boasts one of the lowest soluble salt contents of any globally available abrasive and perceptually holds a competitive advantage in this area of comparison.

Globally, Ecoblast® continues to gain recognition, not only gaining approvals

from major internationally recognised paint suppliers but also though acknowledgements and approvals from major oil companies such as Aramco in Saudi Arabia, Mobil Exxon and Petronas.

Ecoblast is a truly unique South African product that continues to explore and develop new opportunities using local, unique resources.

Committee get-together: Cape Region

The Cape Region Committee had a well attended first lockdown get together on 29 September with 8 of the committee members in attendance. John Houston from Emplast was our very generous host and drinks and the braai were sponsored by him.

We agreed that we would, circumstances permitting try and organise our next Technical Presentation / Site Visit as soon as possible. We have a number of options in the pipeline and we all look forward to having a face to face gathering.

We took the decision to postpone our year end Gala Dinner due to the number of current variables and uncertainty as well as the very trying and challenging times on the business front. We hope to have this sometime early next year and are hoping to maybe link up with OCCA for this celebration.

We were all in agreement that there is a gap in training options for less skilled employees and with asset owners now insisting on certification, this is becoming a problem. There is definitely an opportunity for the Corrosion Institute to fill this gap.

Thanks to all who attended and a big thanks to John for his hospitality. We look forward to the next opportunity of welcoming everyone to one of our get togethers soon. Keep an eye on your email for further information.

Civmec main assembly hall

Once complete, Civmec's purpose-built assembly and maintenance hall in Henderson, Western Australia will be amongst the most efficient and innovative in the world. The 53 000m^2, 18-storey high facility will be the largest undercover modularisation and maintenance facility in Australia.

The 60m ocean-facing sliding doors are amongst the largest in the world, able to house and accommodate the transfer of vessels and large modularised structures, including complete Air Warfare Destroyers, Frigates and Offshore Patrol Vessels.

The new building contains 20 overhead travelling cranes, with the central hall having an impressive 400 tonne lifting capacity. With these cranes allowing only 5mm to 10mm of movement in the building before their sensors shut them down, the 70m high building underwent significant wind tunnel testing in its design phase. Following a 42-page report by James Cook University in Queensland, engineers incorporated over 100 piles into their design for wind stability.

Whilst construction is ongoing, Fero hot dip galvanized 4 100 tonnes of structural steel for the assembly hall between August 2018 and July 2019. There were only 188 days of actual dipping for the whole project (averaging 22 tonnes per day), with peak production of up to 70 tonnes day. The peak production months were December 2018 (averaging 39 tonnes per day over just 15 working days) and February 2019 (totalling 676 tonnes for the month). Fero galvanized over 11 000 individual items, with weights ranging from less than 1kg, right up to 8.5 tonnes.

The use of galvanizing

According to Daryl Brooks (Sales Manager Construction, Fero), "Galvanizing was a much more durable and time and cost-effective surface protection system compared to the equivalent three-coat paint system."

"A three-coat paint system would have cost approximately three times more

initially, taken at least one week per coat to apply, and resulted in a life to first major maintenance of approximately 25 years. In comparison, hot dip galvanizing delivered at least 30 to 60 years to first maintenance," said Brooks.

Early involvement in the design process

Fero was involved during the design phase of the assembly hall – a decision that generated a range of benefits for Civmec.

The steel members – specifically their dimensions – were designed around the size of Fero's galvanizing bath. "Our facility is home to the largest galvanizing bath in the Southern Hemisphere. This meant that Civmec was able to maximise their design – we're readily able to accommodate the galvanizing of larger steel members, compared to just about all other suppliers," said Brooks.

The scale of Fero's operations meant that many of the steel members required a single-dip, rather than a double-dip. With double-dips carrying a much heftier price tag than single-dips, this reduced Civmec's surface treatment costs. It also eradicated the need for the welding of large items on-site, saving labour costs and preventing time-consuming surface treatment touch-ups.

Fero discussed optimum drainage and venting practices with Civmec during the design phase. This meant that when the

steel was delivered to Fero, it could be processed immediately, rather than requiring inspection and potential rework. This allowed Fero to accomplish fast turn-around times, including a same-day service for Civmec's most urgent items (which amounted to anywhere up to 10 tonnes per day).

Fero's early involvement in the design process resulted in the realisation that the steel needed to be blasted prior to galvanizing. This achieved a zinc coating mass of 900g/m^2 for all items, giving the steel a life of 30 to 60 years to first maintenance in a C4 environment. Clearly, even though the assembly hall is located just 100m from the ocean, hot dip galvanizing is a perfectly durable surface protection.

Identification and traceability

Identification and traceability were ironed out early on as well, "At the start of the project, some of the hard-stamps on the steel were filling up with zinc during the hot dip galvanizing process, making them illegible on-site. Fero helped overcome this by advising Civmec (and therefore their detailer) that the hard-stamps need to be facing downwards whilst being dipped, so the zinc would drain out of the hard-stamp, rather than pooling in it," said Brooks.

Fero expedited every piece of steel on the project, syncing their barcode system with Civmec's barcode system. "This meant that Civmec could call us at any time to enquire about an item and we could tell them where it was up to in the galvanizing process and when it would be completed – for full traceability."

"We provided daily lists to Civmec that detailed the loads of steel being sent to site over the next few days, including which items were on each load. This helped the on-site construction team plan ahead. This high degree of traceability meant that no items were lost over the course of the whole project. This would not have been possible without our fully-automated and computerised plant," said Brooks.

Logistical challenges

Working with a compressed timeframe of just 188 days of actual dipping for the whole project, some logistical challenges arose.

Transporting such a large amount of steel from Civmec's fabrication workshop in Henderson to Fero's facility in Kewdale, and then back to site, necessitated dedicated trucks and trailers. These trucks collected and delivered up to eight trailer loads per day. This was the only way that Fero could synchronise their deliveries in line with the requirements and expectations of the construction program.

On occasion, the sheer volume of steel galvanized on daily basis meant that lay-down space available on-site simply wasn't enough. Fero assisted by allocating approximately 1 000m^2 of yard space to store the steel before it was trucked to site. At one point during the project, Fero stored approximately 300 tonnes (equivalent to 20 trailer loads) of hot dip galvanized steel for Civmec.

Project Team

- **Client**: Civmec Construction & Engineering
- **Architect:** GHD
- **Engineer:** GHD
- **Main Contractor:** Civmec Construction & Engineering
- **Steel Fabricator:** Civmec Construction & Engineering
- **Steel Detailer:** Universal Drafting
- **Hot Dip Galvanizer:** Fero Galv (DSI Underground)

We wish to thank Peter Golding of the GAA and acknowledge Sally Wood (sally@wordly.com.au) who as a freelance writer produced this article for the GAA.

Secunda Petrochemical Roadshow

The African Petrochemical had their first roadshow "IPP & Renewables Roadshows", in Secunda, on Friday, 6 November". It was exciting to see all the exhibits that participated and were part of the successful event. We would like to send an extended thank you to everyone who visited our stand and showed interest, we hope to hear from you in the near future.

All future CorrISA events geared for members will commence depending on lockdown regulations. Should you wish to be a part of these events, please send through your tentative booking so that we can contact you once we have finalised the venue and dates. We are looking forward to having you, our members, participate and if you wish to sponsor the event/s please send through your requests to *events@corrisa.org.za* and we will be in touch.

North Western Program Alliance: Frankston Train Station upgrade

The $6.9 billion Level Crossing Removal Project was established by the Victorian Government to oversee one of the largest rail infrastructure projects in the state's history. Central to the project is the elimination of 75 level crossings across metropolitan Melbourne by 2025, in addition to other rail network upgrades, such as new train stations, track duplication, and train stabling yards.

As a major hub linking the Mornington Peninsula to the city of Melbourne, Frankston Train Station was upgraded as part of the Level Crossing Removal Project.

The $63 million upgrade has delivered a brilliant white landmark inspired by the area's coastal terrain, which includes a distinctive, airy, floating canopy, and screens made from corrugated, perforated white metal. Openings in the canopy allow light to fall onto the platforms. The project also encompassed several new buildings, as well as upgrades to the entrance and passenger facilities.

A vital component of the station upgrade was providing protection from the relatively harsh environment in the Frankston area. Located just 600m from the Port Philip Bay coast, the train station had previously experienced corrosion.

To combat this corrosion, Geelong Galvanizing hot dip galvanized approximately 150 tonnes of internal and external structural steel, consisting of large, heavy, curved two- and three-dimensional external frames. Much of this steelwork was then duplex coated, providing a finish with superior durability and corrosion resistance to either galvanizing or paint alone.

The use of galvanizing

Randall Industries designed, fabricated and installed 150 tonnes (3 000m^2) of steel – an easy decision for the project considering their experience in previous successful Level Crossing Removal Projects. With the project specifying that all external structural steel feature a crisp white painted finish, as well as a galvanized base, Geelong Galvanizing was quickly engaged by Randall Industries.

Geelong Galvanizing is the only company in Victoria that offers in-house facilities for galvanizing, painting, and applying duplex coatings (a paint over galvanizing finish) to steel components. Their facilities and skilled

team cater for large-scale steel structures and intricate designs that require an aesthetic finish, in any colour, using a wide range of paint systems.

According to Brad Patton (Blast and Paint Manager, Geelong Galvanizing), "Galvanizing was employed on this project due to the atmospheric condition of the site – it was definitely a C4 environment. While galvanizing was the best option in terms of corrosion protection, the client also wanted a specific aesthetic finish. So, we used a duplex system to deliver a crisp white finish for the job. By combining these two types of corrosion protection, we delivered the best of both worlds."

David Chaston (General Manager, Geelong Galvanizing) agreed, "With galvanizing replacing a typical zinc primer in a three-coat external paint system, a far tougher and more durable base protection was created. By combining both galvanizing and paint, it basically doubled the lifespan of the corrosion protection."

Geelong Galvanizing's two divisions – Galvanizing and Paint – worked together very closely to ensure the best possible surface was created, onto which the final coat of paint could be applied. "We had to ensure that the sometimes-rough surface and imperfections created during the galvanizing process were avoided, producing the best possible surface for the duplex coating," said Chaston.

Duplex coatings can now be specified according to AS/NZS 2312.2, with a longer time to first major maintenance than any external three-coat paint system and galvanizing itself. Bringing these two protection methods together offers less overall maintenance and a longer lifespan, providing an extended, sustainable future for Frankston Train Station.

Overcoming challenges

As with any prominent infrastructure project, Geelong Galvanizing encountered some challenges along the way. The majority of the structural steel members were awkward heavy frames, many of which required double dipping.

To overcome this, and ensure the large frames were handled as effectively as possible, Geelong Galvanizing employed custom jigging techniques during the double dipping process, ensuring the frames were not damaged.

"During the galvanizing process, we had to ensure that there were no runs, no excessive build ups, and that the steel was not damaged. Galvanizing is, obviously, a very industrial process, with manual handling and extensive use of cranes," said Chaston.

"So, the challenge was to maintain structural integrity, whilst also achieving the best

possible finish prior to adding the paint. We had to change our internal procedures for some of the members – their unique shapes necessitated individual dipping, which is outside our normal galvanizing parameters."

Teamwork and extensive consultation with all project stakeholders were integral to overcoming challenges and delivering a successful project.

"We undertook extensive consultation with the stakeholders on venting and draining issues to ensure an excellent surface finish, with little aesthetic loss due to unsightly holes and crop outs. We also ensured the fettling was correct and undertook painstakingly detailed quality control checks throughout the galvanizing process to deliver a quality finish on which our Paint division could apply the final coatings," said Patton.

The benefit for industry

This project brings galvanizing and painting together as a corrosion protection force, with the benefits of both systems interacting to provide the best solution for the client.

"This was a significant, sexy project. It really showcases the advantages offered by a duplex system. Hopefully, the project demonstrates to architects and specifiers that galvanized steel can be produced in any colour. Industry seems to believe that galvanized steel can only be delivered in silver, which is a hugely limiting factor. The Frankston Train Station Upgrade demonstrates the flexibility of galvanized steel," said Chaston.

According to Patton, "I really hope the project demonstrates the advantages of bringing the two industries – galvanizing and painting – together. There have been times when painters are reluctant to paint over galvanizing because of a perceived lack of adhesion. Clearly, this is not the case. The complexity of the Frankston Train Station project demonstrates that galvanizing does not have any limitations. The only limitation is the size of the galvanizing bath, which is the same for every project. Anything that can be galvanized can be painted."

Frankston Station demonstrates big-picture, long-term thinking, bringing together the benefits of galvanizing protection while creating a desirable colour finish.

Project Team

- **Developer and Owner:** North Western Program Alliance
- **Architect:** Genton
- **Steel Fabricator:** Randall Industries
- **Hot Dip Galvanizer:** Geelong Galvanizing
- **Painter:** Geelong Galvanizing Paint Division

We wish to thank Peter Golding of the GAA and acknowledge Sally Wood (sally@wordly.com.au) who as a freelance writer produced this article for the GAA. .

From the KETTLE

The role specifiers and end-users have in selecting a corrosion control coating, suggests that all aspects of a hot dip galvanized coating be highlighted and if necessarily de-mystified. The intension of this series of surface conditions is to ensure that the customer or specifier has a greater understanding of the coating so that it is not necessarily rejected or accepted for the wrong reasons, resulting in wasted time for all personnel. See F30 and F31.

Legend
A Accept **R** Reject **REP** Repair

F30

DESCRIPTION:

Solidified zinc trap.

CAUSE:

Similar to an air trap, adequately sized drainage holes must be provided to allow excess, molten zinc to drain from the components as they are withdrawn from the molten zinc.

EFFECT / REMEDY:

Other than increasing the mass of the component, a zinc lump is not rejectable unless situated on a mating surface, bolt hole or significant surface (SS).

ACCEPTABLE TO SANS 121:

A

Unless at SS, bolt hole or mating surface.

ACCEPTABLE FOR DUPLEX AND ARCHITECTURAL FINISH:

R and remove using appropriate methods.





F31

DESCRIPTION:

Ensure component is structurally sound and has appropriate vent / fill drainage holes.

CAUSE:

When tubular components are to be hot dip galvanized it is the responsibility of the engineer, fabricator or end user to ensure that the component is correctly vented and is structurally sound.

The shear mass of molten zinc contained in the structure as the component slowly exits the bath, will place huge stress on the component and if too weak will extensively distort, leading to unacceptability.

EFFECT / REMEDY:

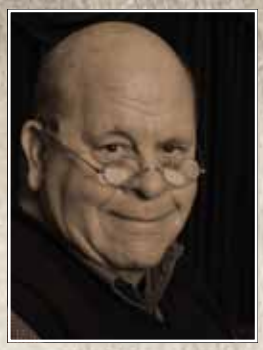
This 12.0m x 3.1m high gate (right) was manufactured from 1.6mm thick RHS's and supplied with inappropriate vent / fill and drainage holes which when removed from the molten zinc bath had approximately two tons of molten zinc inside the tubes. Consequently the gate bowed unacceptably due to its overall mass at exit.

ACCEPTABLE TO SANS 121:

R

ACCEPTABLE FOR DUPLEX AND ARCHITECTURAL FINISH:

R

In Loving Memory
BOB ANDREW

14th April 1944 – 10 October 2020

My Dad has been a part of my life since I was 12 years old, while we were both getting to know each other, He shared with me his love for music, his favourites being Creedence Clearwater Revival and the Beetles of course. We would often have Karaoke nights which he thoroughly enjoyed, we laughed for hours on end.

His knowledge was so vast and diverse, one could easily take part in hours of animated stories, ideas and theories. His favourite subjects being Astronomy, history, music, art, culture, movies and books of all sorts and the occasional Sherlock Holmes episode.

I admire my Father for having such a strong belief that all cultures and everything that goes with it is beautiful and unique and must be respected for what it is. He instilled in us to see the beauty in diversity and seek new ways and embrace change.

I will forever be grateful, not only for the wonderful fun filled memories, but also for opening my mind up to the "world out there" it inspires me every day. He always said, "one can never stop learning new things as you will never run out of things to learn". He had such a great passion for our country where the National Anthem made him emotional and proud to be part of it all.

We will miss him dearly and will forever hold his memory close to our hearts and be most thankful for all the lessons he taught us.

He leaves behind his wife, Iris Andrew; daughters, Muriel and Diane; and grandchildren, Marcus, Cameron, Chalib, Skylar and Liam.

I met Bob Andrew way back in 1996 when I joined Walter Barnett at the HDGASA. Bob was then at JCI and because he and Walter had been working together for some time on the use of hot dip galvanized steel in mining and I was employed to promote the coating with an endless list of specifiers.

One of the first projects I can remember where Bob played a leading role was a PGM Concentrator Plant facility near Rustenburg. Due to the aggressiveness of many concentrator plants most asset owners steered away from galvanizing. So when it was specified to be used on all structural steel at this plant, it was a huge step in the right direction.

Bob introduced the concept of "business partnership" where in terms of a successfully completed project on time and less than budget all players benefited financially.

At the HDGASA I was responsible for producing the quarterly magazine "Hot Dip Galvanizing Today" and for many years Bob wrote a column for the publication called *"Bob's BANTER"* which was always received with interest by our readers.

Lastly while Bob and Walter presented a number of technical papers to International Galvanizing Conferences, Bob eventually wrote a very valuable book on "Practical Guidelines for Corrosion Protection in the Mining and Metallurgical Industry"

Our sincere condolences to Bob's family.

Terry Smith

RUST'S A MUST

Mighty ships upon the ocean
Suffer from severe corrosion,
Even those that stay at dockside
Are rapidly becoming oxide.
Alas, that piling in the sea
Is mostly Fe2O3.
And where the ocean meets the shore,
You'll find there's Fe3O4.
'Cause when the wind is salt and gusty,
Things are getting awful rusty.

We can measure, we can test it,
We can halt it or arrest it.
We can gather it and weigh it,
We can coat it, we can spray it.
We examine and dissect it,
We cathodically protect it
We can pick it up and drop it.
But heaven knows we'll never stop it!
So here's to rust, no doubt about it,
Most of us would starve without it.

Acknowledgement to
T.R.B. Watson Corrosion Services Company, Ltd.
Toronto, Canada
Contributed by Gerrit Cloete

Executive Director – Petra Mitchell

Tell us something of your background and experience in corrosion related issues and why you think you were selected for the Directors position at CorrISA?

My journey started with the Corrosion Institute in 2016 when I was approached to assist with the accreditation of the local courses. I'm a skills development professional and been part of the construction industry more so on the training and development side for over 10 years. In 2012 I was part of the working group that started with the development of the Building Insulation Installer qualification led by Master Builders KwaZulu-Natal. In May 2016, the Thermal Insulation Products and Systems Association SA (TIPSASA) requested the expansion of the Building Insulation Installer qualification to include the Industrial Insulation Installer with the Manufacturing, Engineering and Related Services SETA (MerSETA) as the Development Quality Partner (DQP).

I also played a vital role as the Learner Qualifications Development Facilitator (LQDF) where I lead a group of industry experts in the development of the insulation installer qualification which was completed and registered with the South African Qualifications Authority (SAQA). This curriculum also included corrosion under insulation.

Apart from meeting all the requirements in the job specification, and having the right skills, experience and tenacity for this position, I think my broad industry experience in government, Sector Education and Training Authorities (SETAs) and curriculum development for industries was one of the main reasons I was selected for the Director position at CorrISA.

What are your initial thoughts of taking CorrISA to the next level of success in corrosion and corrosion control?

In order to move the Institute to the next level we need to improve our course offerings, finalisation of the Corrosion and Coatings Professional Body of South Africa and finalise our improved website and membership database. In addition, we need to relook at our membership benefits and improve on them. The Professional Body will safeguard the public interest and the interest of the professional practitioners, the courses withll be the baseline and or minimum training criteria a professional must have in order to practice. In other words, the Professional Body will have direct oversight over industry practices and standards.

Any thoughts of how you would like to sustain the current membership?

What I have learned over the years and in my own experience as a member of other associations we need to discover why our members have joined in the first place and do more of it. We are currently in the process of doing just that and developing a new and improved membership benefits. We take for granted that our current members know what we offer them, therefore we need to remind our members of their benefits on a regular basis. Sustainable memberships are the result of companies that have sustainable operations. My task is to ensure that the internal processes and operations run smoothly in order for us to serve our members the best way possible.

Any thoughts on how you and your team can expect to increase membership?

Before we can increase membership we need to understand what our current members want and need. In addition, we need to look at more tangible benefits to our members, e.g. the Institute in partnership with Cape Business News has a new membership benefit where members receive a free Featured Listing worth R4000.00 from Cape Business News Directory. We need to increase our communication to our members. Different service offerings. Offering member-only sections on our website e.g. creating a section on our website that normal visitors can't see can help generate interest.

What would you like to tell the readers of Corrosion Exclusively about what the Corrosion Institute has been doing since our last publication in February?

Life really seemed to have taken a tumble with all and everything almost coming to a standstill at the time of lockdown. Due to the COVID-19 pandemic and national lockdown all the courses, events etc. was put on hold.

The team packed their laptops, printers, files etc. to work from home, which also had some of its challenges. They all converted a room in their homes into their "home office".

I was amazed at the ideas, new technology and the creative responses to the coronavirus lockdown in the press and on all communication and media platforms. One wonders whether we will ever be able to return to life 'as we knew it and as it used to be' prior to this breakout.

When I started in September 2020 it was business as usual, where we picked up from the devastation COVID-19 left us. In saying that we have already run two courses. CIP1 in September and Corrosion Engineering in October 2020. We are scheduled to have a CIP1 and CIP2 course in November/December 2020.

You now are leading an all "girls" team of individuals any thoughts on your strengths or weaknesses?

My biggest strength is that I'm very efficient at working under pressure. No matter the crisis or stress, I can make the right decisions on-the-spot. As a skills development professional I'm faced daily with deadlines that are sometimes close to impossible, instead of getting overwhelmed I would arrange the task in order of importance and sort through the tasks one by one. Another strength is also my intellectual curiosity. I enjoy researching the latest trends in order to stay abreast of any policy and or legislation changes that affects the industry. The advantage of working in all "girls" environment adds to our attention to detail.

Tell us a bit about your personal life, married, children, dogs or cats? Sports or how you handle your stress?

I'm married with 8-month-old boy/girl twins. I love the outdoors, extreme sports and rugby – yes I still support the Stormers. I actually work better under pressure, and I've found that I enjoy working in a challenging environment. I thrive in an environment where no two days are alike. I try to react to situations rather than to stress. That way, I can handle the situation without becoming overly stressed.

In terms of your goals and priorities as Director of the Corrosion Institute what vision do you have for the Corrosion Institute in say 5 years' time?

CorrISA's main objective is to provide a forum for the enhancement of multi-disciplinary corrosion control science, technologies and professional expertise in Southern Africa. My goals and priorities to take CorrISA there through the Professional Body, its new and improved training initiatives and membership benefits. We are currently in consultation with a consultant together with the EXEC to work with us on a 5 year strategic plan for the Institute. This will enable continuity in the organisation. I'm excited and look forward to take this leadership role as a market leader such as CorrISA. I am steadfast and ready to lead the team to be their best and the best at servicing our members.

Comment – Chairman of the Cape Region

Lockdown has been a very challenging period for most companies and individuals and we have all been affected in some way. The Corrosion Institute Cape Region activities have unfortunately also been limited with no Technical presentations, AGM or site visits being possible during this period. We also missed out on our yearly Mini Expo as well as our Fireside chat.

The committee did manage to meet up and make plans for next year and we hope to be able to kick next year off with a bang. We have taken the decision to move our usual end of year Gala Dinner to next year and will keep you posted with proposed potential dates.

Depending on the latest lockdown status we might try and squeeze a Technical Presentation or site visit in before the end of the year but that will depend on how things develop in the next few weeks.

Once there is more clarity, we will communicate this via email.

Yours in Corrosion,
Graham Duk on behalf of Bryan Bauermeister, Dan Durler, Daryl Livesey, Flippie van Dyk, Gilbert Theron, Hilton Olivier, Indrin Naidoo, John Houston, Lucinda Blanchard, Pieter van Riet and Terry Smith

Comment – Vice Chairman of KwaZulu Natal

As with the rest of the world, the KZN branch took a hard knock when the pandemic hit our shores. The Regional committee had hosted a string of meetings at the beginning of 2020 to form a plan in an attempt to grow the regional hub by targeting asset owners and new plants within the KZN region.

With the plan formulated, the regional committee was increased from two members to five by bringing in key players from the contracting and 3rd party inspections industry.

The new committee was introduced at the year's first technical evening hosted by BAMR and Elcometer UK which turned out to be a great success with around 30 attendees, this was the perfect start to 2020. With a host of NACE and CorriSA courses lined up for the KZN region accompanied by some interest from local companies to present their experiences at technical evenings we made the decision to attempt reviving the bi-weekly technical evening meet ups, all was on track until the pandemic hit us.

With all gatherings prohibited and the courses having to be postponed, the regional committee made the decision to put plans on hold while the country works together to get through this pandemic.

Many local construction sites were put on hold and our larger assets such as the refineries and ports completely abandoned in the attempt to lower the exposure rate, this put many of our fellow industry colleagues on the backfoot leaving all in the industry wondering whether to continue pursuing corrosion maintenance as indeed the only way forward.

Since the reopening of local sites we have begun to see the coatings and corrosion prevention industry reopen slowly with great prospects for the future, with asset owners now having had the time to survey the condition of the assets and set forth plans for 2021.

The KZN regional committee sees this as an opportunity to get involved and once again revive the Institutes involvement in large projects and development of students within the corrosion industry.

We invite all company, industry professionals and asset owners to attend and/or host technical events in 2021. The committee commits to follow all Covid-19 regulations regarding gatherings and supports the drive to control this virus. We have accepted that this will be a part of life moving forward and will do our best to continue hosting these events and growing the Institutes membership.

Marco Ashburner
KZN Regional Vice Chairman

Courses restart after Covid-19 Lockdown

The wait for the COVID-19 lockdown to be lowered to Level 1 was a challenge to one and all but we are happy to report that we eventually managed to start up with running our courses once again.

The first CIP 1 course since the beginning of the pandemic was held, under the strictest protocol and safety precautions from 28 September – 3 October 2020. 12 students were in attendance.

The many hours invested in drawing up of SOP's for the courses included temperature readings, social distancing, sanitising stations, forms and catering. The success of this first course was a great reward for one and all and has demonstrated the way forward in these unprecedented times.

Thank you to our Company Members, Stoncor for supplying the paint requirements and Corrocoat Benoni for hosting the practical day that was held on Thursday, 1 October 2020.

We were fortunate enough to also run Corrosion Engineering course with 5 students attending.

Training is indeed in full swing! We look forward to the success of all the forthcoming courses. In the meantime, stay safe.

Linda Hinrichsen, Course Administrator

CIP1 TRAINING COURSE: 3rd October 2020

CORROSION ENGINEERING COURSE: 2nd - 6th November 2020

THE CORROSION INSTITUTE OF SOUTHERN AFRICA
COURSE SCHEDULE 2020/2021

NACE CIP 1 – Coating Inspector Program

25th – 30th January 2021	The CORē, Midrand
22nd – 27th February 2021	Cape Town
15th – 20th March 2021	The CORē, Midrand
12th – 17th April 2021	KwaZulu Natal
24th – 29th May 2021	The CORē, Midrand

NACE CIP 2 – Coating Inspector Program

7th – 12th June 2021	The CORē, Midrand

NACE CP 1 – Cathodic Protection Tester

21st – 25th June 2021	The CORē, Midrand

NACE CP 2 – Cathodic Protection Technician

1st – 5th February 2021	The CORē, Midrand

Corrosion Engineering

1st – 5th March 2021	The CORē, Midrand

Corrosion Management

7th – 8th December 2020	The CORē, Midrand
15th – 16th February 2021	The CORē, Midrand

Not Just Rust

24th February 2021	The CORē, Midrand
19th May 2021	The CORē, Midrand

NACE – Corrosion Control in the Refining Industry

26th – 30th April 2021	KwaZulu Natal

NACE Marine Coating Technology

17th – 20th May 2021	KwaZulu Natal

NACE Corrosion & Protection of Concrete Structures and Buildings

12th – 13th April 2021	The CORē, Midrand

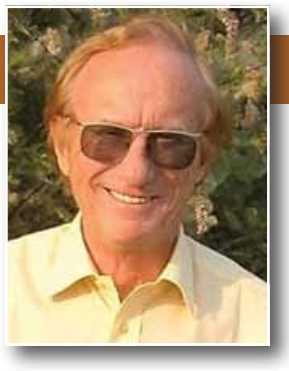
CP 101 : Cathodic Protection Explained

10th – 11th December 2020	The CORē, Midrand

REGISTRATION LINK: https://docs.google.com/forms/d/1e9ZGDsMO1Sd8aXuCvys2bstXr5SrpVBxuqEQPK9lfUM/viewform?c=0&w=1

The RUST Spot...

in conversation with Professor Denis Twigg



At the age of 39 years I emigrated with my family from England to live in South Africa – a period which lasted 32 years. My wife is Margaret and we have three children.

Working life

The high point of my working life was when the Council of the Port Elizabeth Technikon (later designated Nelson Mandela Metropolitan University) appointed me a Professor on 30 April 1996. My age at that time was 61 years old and I was the Head of Department - Materials and Metallurgical Engineering. This reward was in recognition of my academic standing and achievements during the whole of my career including that in the UK.

South Africa

South Africa involved changing my work experience and responsibilities several times over the 32 years.

Summarising my senior positions and responsibilities during the 32 years in South Africa:

- Appointed Professor of the Nelson Mandella University (NMU) Port Elizabeth.
- Head of Materials and Metallurgy NMU
- Head of Department, South African Bureau of Standards.
- Executive Director, South African Hot Dip Galvanisers. Association. (Honorary Life Member)
- Chairman Welding Institute
- Chairman South African Branch of the UK Institute of Materials, Minerals and Mining (Honorary Life member).
- Principal Consultant, Cormet Executive – a sole proprietorship business
- Chairman of the Eastern Cape Action Group for Corrosion Protection.

Technical qualifications

- PrSciNat: registered South African Natural Scientist
- MSc: University of Bradford
- FIMM: Fellow of the UK Institute of Materials, Minerals and Mining. Chairman of the South African Branch and Honorary Life Member. Chartered Engineer.
- Fellow South African Corrosion Institute
- Fellow South African Institute of Welding
- Fellow Institute of Ceramics UK
- Honorary Life member of the South African Hot Dip Galvanizers Association
- Fellow South African Institute of Mining and Metallurgy

Our family lives in South Africa

It was initially a massive life change from living in England.

The Urban Areas Act gave White Local Authorities the Power to Exclude Blacks from White Areas.

Within 30 years since our arrival in South Africa there was rapid and fundamental change.

Amazingly since the transmission of power in 1994 there was steady transition – political, social and economic.

Before the transition my wife and I were alarmed when our two sons were drafted into the South African Army to fight for no change to Apartheid which we opposed!

South Africa has a population of about 42 million. Black people number about 37 million and whites about 5 million, those of Asian Origin about one million and the coloured mixed descent approximately 4 million. It became apparent that change would come to South Africa, as it eventually did.

South Africa now has a democratically elected President and the educational opportunities in South African Universities are now open to all of the communities.

Return to live in England 2006

For family reasons a time had come to return to live again in the UK. I was contracted on return to part-time lecturing around England. These assignments included the following organisations: Hortsman Defence; Serco; National Association of Steel Stockholders; Doosen Babcock; Weir Valves; Corus Steel; Alston Power.

I have returned to South Africa several times to lecture to students and engineers.

My past working life in the UK included lecturing to students in UK Universities and Colleges.

I enjoyed my life in South Africa well supported by my wife Margaret.

I am still contacted for my opinion in areas of my expertise including Corrosion Prevention and Metal Failure Analysis.

GALVANIZED REINFORCEMENT IN CONCRETE STRUCTURES

An introduction booklet for Engineers & Designers

GALVANIZED REINFORCEMENT IN CONCRETE STRUCTURES, produced by the Galvanizers Association of Australia. Copies of this booklet can be freely downloaded from ***https://gaa.com.au/technical-publications/*** after registering.

The Editor wishes to thank Peter Golding, Chief Executive Officer of the GAA for this publication.

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