Official Publication of The Australasian Corrosion Association Inc • www.corrosion.com.au

CORROSION & MATERIALS

Vol 40 No 3, June 2015
ISSN 1326 -1932

Inside this Issue:

CELEBRATING 60 YEARS 1955 – 2015

AUSTRALASIAN CORROSION ASSOCIATION INC.


JOTUN
Jotachar
the time saving solution
Mesh-free Jotachar wins on time and cost savings
Chosen for Passive Fire Protection projects across the globe
Tested under the toughest conditions, 350kw/m2 Jet Fire Test


JOTUN

CORROSION & PREVENTION 2015

CONCEPT | IMPLEMENTATION | MONITORING | OUTCOMES

Proudly presented by:

Australasian Corrosion Association Inc.

Major Sponsor:

JOTUN

Adelaide, South Australia
15–18 November 2015

Early Bird Registration:

Register before 21 August for discounted conference registration fee.

Corrosion & Prevention is the annual conference of the Australasian Corrosion Association, it's a 4 day gathering of world experts on corrosion mitigation. This will be a premium networking event as well as a source for the latest information concerning corrosion mitigation.

Entitled Corrosion & Prevention 2015, the conference will feature a program of keynote speakers and presentations under a range of industry streams and is expected to attract approximately 450 - 550 delegates. Corrosion & Prevention 2015 also features an extensive exhibition of key industry suppliers.

In 2015 we invite you to the vibrant city of Adelaide, which is internationally regarded as a wine and food mecca, add in a temperate Mediterranean climate and Adelaide is the ideal place for mixing business with pleasure. All in all, this promises to be an enlightening, exciting and highly enjoyable conference.

The conference will be integrated with an exhibition which will showcase the products and services within the corrosion mitigation industry.

Technical Streams

Over 100 abstracts have been peer-reviewed and accepted.

The key technical streams include:

- Advances in Sensing & Monitoring
- Asset & Integrity Management
- Cathodic/Anodic Protection
- Concrete Corrosion & Repair
- Corrosion Mechanisms, Modelling and Prediction
- Education & Research
- Materials Selection & Design
- Non-Destructive Evaluation (NDE)
- Protective Coatings

These technical streams cover a range of industry sectors including Oil & Gas, Water & Wastewater, Power and Energy, Marine Infrastructure and more.

For further information contact the Australasian Corrosion Association Inc on +61 3 9890 4833, Email: conference@corrosion.com.au or refer to www.acaconference.com.au

CONTENTS

Corrosion & Materials

Corrosion & Materials is the official publication of The Australasian Corrosion Association Inc (ACA). Published bi-monthly, *Corrosion & Materials* has a distribution of 2,500 to ACA members and other interested parties. Each issue features a range of news, information, articles, profiles and peer reviewed technical papers. *Corrosion & Materials* publishes original, previously unpublished papers under the categories 'Research' and 'Professional Practice'. All papers are peer reviewed by at least two anonymous referees prior to publication and qualify for inclusion in the list which an author and his or her institution can submit for the ARC 'Excellence in Research Australia' list of recognised research publications. Please refer to the Author Guidelines at www.corrosion.com.au before you submit a paper to Brendan Pejkovic at bpejkovic@corrosion.com.au with a copy to bruce.hinton@monash.edu

ACA also welcomes short articles (technical notes, practical pieces, project profiles, etc.) between 500 – 1,500 words with high resolution photos for editorial review. Please refer to the Article Guidelines at www.corrosion.com.au before you submit a short article to Brendan Pejkovic at bpejkovic@corrosion.com.au

The Australasian Corrosion Association Inc

The ACA is a not-for-profit, membership Association which disseminates information on corrosion and its prevention or control by providing training, seminars, conferences, publications and other activities.

Vision Statement

Reducing the impact of Corrosion.

THE WORLD CORROSION ORGANIZATION

The ACA is a founder member of the World Corrosion Organization

Front Cover Photo:
Zinc spray galvanic protection.
Images supplied by Freyssinet.

CORROSION & MATERIALS

ISSN 1326 -1932

Published by The Australasian Corrosion Association Inc.
ABN: 66 214 557 257

Editor

Ian MacLeod – Western Australian Museum
ian.macleod@museum.wa.gov.au

Associate Editors

Research: Bruce Hinton – Monash University
bruce.hinton@monash.edu

Professional Practice: Willie Mandeno – Opus International Consultants
willie.mandeno@opus.co.nz

News: Tracey Winn – The Australasian Corrosion Association Inc,
twinn@corrosion.com.au

Reviewers

Andy Atrens – University of Queensland
Nick Birbilis – Monash University
Frederic Blin – AECOM
Lex Edmond
Harvey Flitt – Queensland University of Technology
Maria Forsyth – Deakin University
Rob Francis
Warren Green – Vinsi Partners
Graeme Kelly – Corrotec Services
Grant McAdam – Defence Science & Technology Organisation
David Nicholas – Nicholas Corrosion
Graham Sussex – Sussex Material Solutions
Tony Trueman – Defence Science & Technology Organisation
Geoffrey Will – Queensland University of Technology
David Young – University of New South Wales

Advertising Sales

Tracey Winn – The Australasian Corrosion Association Inc,
twinn@corrosion.com.au
Ph: 61 3 9890 4833 | Fax: 61 3 9890 7866

Subscriptions

Print Version: ISSN 1326-1932
Subscription rates:
Within Australia AUD $80.00 per annum incl GST
Outside Australia AUD $85.00 per annum excl GST posted airmail

The Australasian Corrosion Association Inc

PO Box 112, Kerrimuir, Victoria 3129, Australia
Ph: 61 3 9890 4833
Fax: 61 3 9890 7866
E-mail: aca@corrosion.com.au
Internet: www.corrosion.com.au

ACA Board

Paul Vince (Chair)
Kingsley Brown
Graham Carlisle
Peter Dove
Allan Sterling
Dean Wall

ACA President: Mohammad Ali
ACA Senior Vice President : John Duncan
ACA Junior Vice President: Matthew Dafter
ACA Executive Officer: Wesley Fawaz

ACA Branches & Divisions

Auckland Division: Grant Chamberlain	64 21 245 9038
Newcastle: Nathan Spencer	61 439 511 836
New South Wales: Jim Galanos	61 2 9763 5611
Queensland: Francis Carrol	61 0404 494 699
South Australia: Dennis Richards	61 0 419 860 514
Tasmania: Grant Weatherburn	61 0 418 120 550
Taranaki Division: Ron Berry	64 27 671 2278
Victoria: John Tanti	61 3 9885 5305
Wellington Division: Monika Ko	64 4 978 6630
Western Australia: Phil Schmidli	61 4 5148 0090

ACA Technical Groups

Cathodic Protection: Bruce Ackland	61 3 9890 3096
Coatings: Matthew O'Keeffe	61 437 935 969
Concrete Structures & Buildings: Frédéric Blin	61 3 9653 8406
Mining Industry: Ted Riding	61 3 9314 0722
Petroleum & Chemical Processing Industry: Fikry Barouky	61 402 684 165
Research: TBA	
Water & Water Teatment: Matthew Dafter	61 419 816 783
Young Corrosion Group: Giles Harrison	61 439 513 330

*all the above information is accurate at the time of this issue going to press.

CONTENTS

Vol 40 No 3, June 2015

The ACA celebrates 60 years in 2015.

Mohammad Ali
President

Hello fellow ACA members.

This is my first communique as the ACA President in *Corrosion & Materials*.

It is not that I intended to be an absentee President; it's due to the fact that the ACA has had a change of Constitution and position descriptions of various ACA roles have been reviewed.

You may have noticed that there is now a regular Chairman's message and in future, the Chair and President will share messages to members in *Corrosion & Materials*.

To introduce myself, I am originally from Bangladesh. I immigrated to Australia 20 years ago and have been working in the corrosion field for most of my time in Australia. I have been involved with ACA for more than 15 years. During this time, I served as ACA NSW Branch President, ACA Publications Director, and ACA Councillor.

Since the last ACA Conference in Darwin, the ACA is making great progress toward improving the governance of our Association. A few points to note:

- A Board Charter which defines the roles, responsibilities and authorities of the Board is now available on the ACA website.
- A Council Charter which defines the roles, responsibilities and authorities of the Council is also now available on the ACA website.
- A Branch Manual has been drafted as a guideline for Branch Committees.
- An Audit, Finance & Risk Sub Committee of the Board has been established.
- A Governance Sub Committee of the Board has been established.
- The Board has finalised a skills matrix for Board Directors and these will be announced when calling for future Directors.
- A formal risk management program is being designed by the Board.
- The AGM was held last month to comply with the South Australian Incorporations Act.
- A 2014 annual report was provided to members and is still available on the website for those members who haven't viewed this yet.

As President of the ACA, I feel privileged and proud to be the President of this prestigious organisation and represent you, the members and I now hope to communicate with you further during my tenure.

Next month, I shall be inviting all interested ACA members to nominate a suitable person to serve on the Board. Nominations will be reviewed by members of the ACA Council and elected at the Council meeting on Sunday 15 November 2015.

On other matters, how are we the corrosion professionals doing? I would have thought that we are all busy and doing fine! With the exception of NSW, other Australasian cities are not necessarily spending much on new infrastructures (if I am correct) and their infrastructures are in maintenance mode. The corrosion professionals can efficiently use their knowledge in corrosion management and maintenance of the aging infrastructure. Personally I have observed that even for new construction, durability and corrosion management is a mandatory requirement in the Deed for Scope of Work and Technical Criteria (SWTC).

To serve the industry well, we have to improve our knowledge base through research and participating in technical events. ACA fortunately organises numerous technical events and I suggest that you make every effort to participate in some of our events.

I would like to conclude my column with a quote by a Bengali Poet (Rabindranath Tagore, a Nobel Laureate in Literature) '*Everything comes to us that belongs to us if we create the capacity to receive it*'. In this world, we all surely try to create some capacities!!

Mohammad Ali
President

ACA 2015 Events Calendar

Part of the role of the ACA is to organise events that bring together industry experts to present on new technologies, updates to standards, and share knowledge and experiences via case studies on a variety of projects. 2015 will be no different, with the events listed below scheduled in our Calendar of Events.

Event Title	Event Date	Event Location
Concrete Assets – Experiences with Repair & Maintenance	25 June 2015	Perth
APGA/ACA - Pipeline Corrosion Management	23 July 2015	Brisbane
Introduction to Corrosion	30 July 2015	Melbourne
Introduction to Corrosion	30 July 2015	Sydney
Protective Coatings	13 August 2015	Perth
Corrosion in the Oil & Gas Industries	27 August 2015	New Plymouth
Corrosion in the Power & Energy Industry	3 September 2015	Brisbane
Concrete Corrosion	17 September 2015	Sydney
Corrosion & Prevention 2015 Conference	15 – 18 November 2015	Adelaide

ACA members will receive further details on each event as appropriate throughout the year, but for now, please include these in your 2015 diary. For further information on these events for 2015 please don't hesitate to contact Brendan Pejkovic (bpejkovic@corrosion.com.au) in the ACA office on +61 3 9890 4833.

Branch Events

Each of the 8 ACA Branches will conduct regular technical events throughout 2015. To enquire, you may contact your local Branch at the following email addresses:

New South Wales: nsw@corrosion.com.au
New Zealand: nz@corrosion.com.au
Newcastle: ncl@corrosion.com.au
Queensland: qld@corrosion.com.au
South Australia: sa@corrosion.com.au
Tasmania: tas@corrosion.com.au
Victoria: vic@corrosion.com.au
Western Australia: wa@corrosion.com.au

YCG Events

Targeting individuals under 35, new to the corrosion industry and/or interested in the corrosion industry, the ACA Young Corrosion Professionals conduct regular events. For further details email ycg@corrosion.com.au or go to www.corrosion.com.au

ACA YCG
THE AUSTRALASIAN CORROSION ASSOCIATION INC
YOUNG CORROSION GROUP

Please refer to **www.corrosion.com.au** for up to date details on all ACA activities.

Wesley Fawaz
Executive Officer

The ACA AGM was held last month in Melbourne. The AGM has usually been conducted during the annual conference, but in accordance with the South Australia Associations Incorporations Act 1985 (in which the ACA is incorporated) the AGM must be held within five months of the end of our financial year (which is the calendar year).

Chairman Paul Vince managed the meeting and motions to accept the minutes of the 2014 AGM, Presentation of the 2014 Annual Report, Presentation of the Audited Financials Statements and the appointment of Baumgartner Partners as the 2015 auditors were all carried.

For those members who haven't read through the 2014 Annual Report, it is available on the ACA website (About Us webpage). The report highlights the achievements, provides membership statistics and segmentation details, a review of the years activities, as well as the audited financial statements compared to 2013.

Members should be aware of the financial position of the ACA. The Statement of Comprehensive Income on page 14 of the report shows revenue of $3,295,547, expenses of 3,228,149, and a net surplus of $67,398. The Statement of Financial Position has the Total of Members Funds at $1,476,081.

If you have any queries from the Annual Report, please do not hesitate to contact me.

In the first five months of 2015, the ACA has provided 45 opportunities for networking and professional development. The New Zealand Branch should be congratulated for what is now regular activity in Christchurch, New Plymouth and Auckland. As a result, membership in New Zealand over the past 12 months has increased greater than any other Branch, the NACE CIP Level 1 next month in Auckland has sold out and there are ACA courses scheduled there in the second half of the year. This is great momentum in New Zealand leading up to the 2016 ACA conference in Auckland.

Inserted in this issue of Corrosion & Materials is the annual conference Preliminary Program & Registration Brochure. Registrations have recently opened and what will make Corrosion & Prevention 2015 (Adelaide 15-18 November) a great success, is a balanced mix of registrations from asset owners, consultants, contractors, academics and suppliers. Jotun have supported the conference as major sponsors, most sponsorship opportunities have sold and the 65 booth exhibition has sold out. The conference offers something for all aspects of our industry, so I encourage you all to proactively seek approval from your employers to attend and register now.

Wesley Fawaz
Executive Officer
wesley.fawaz@corrosion.com.au

THE AUSTRALASIAN CORROSION ASSOCIATION INC.

TRAINING

ACA Training Calendar 2015

ACA/ACRA Corrosion and Protection of Concrete Structures

Member $1060   Non-member $1330

Adelaide August 20 – 21

Perth October 13 – 14

ACA Coating Inspection Refresher

Member $605   Non-member $740

Adelaide November 14

Auckland December 4

Cathodic Protection Monitoring

Member $1485   Non-member $1810

Sydney August 3 – 5

Adelaide August 31 – September 2

Perth October 5 – 7

Melbourne October 26 – 28

Cathodic Protection Advanced

Member $2220   Non-member $2600

Auckland September 14 – 18

Perth November 30 – December 4

Coating Selection and Specification

Member $1485   Non-member $1810

Perth August 10 – 12

Corrosion Technology Certificate

(Also offered as Home Study)

Member $2220   Non-member $2600

Melbourne September 21 – 25

Sydney November 23 – 27

CTC Home Study

Member $2220   Non-member $2600

Start any time

NACE CIP Level 1

Member $3740   Non-member $4275

Brisbane July 20 – 25

Perth August 17 – 22

Sydney September 7 – 12

Melbourne October 12 – 17

Adelaide November 2 – 7

NACE CIP Level 2

Member $3740   Non-member $4275

Sydney June 22 – 27

Auckland July 13 – 18

Brisbane July 27 – August 1

Perth August 24 – 29

Melbourne October 19 – 24

Adelaide November 9 – 14

NACE CIP Level 3 Peer Review

Member $1470   Non-member $1725

Adelaide November 9 – 13

Protective Coatings Quality Control

Member $1485   Non-member $1810

Sydney July 1 – 3

Perth September 14 – 16

Metallurgy of Steels Introduction

Member $1485   Non-member $1810

Sydney July 22 – 24

All Australian course fees listed are GST inclusive.
All NZ course fees are exempt from GST.
To calculate the fee pre-GST, divide the fee by 1.1

Industrial Galvanizers Wins International Galvanizing Award

Industrial Galvanizers is delighted to announce that the Austin Car Park Extension, for which the Company provided the hot-dip galvanized coating, has won the American Galvanizers Association - Excellence in Hot-Dip Galvanizing INTERNATIONAL AWARD 2015.

This is significant international recognition for the entire Project Team involved in delivering a long-lasting, attractive, functional infrastructure.

It underlines the value of hot dip galvanizing in providing a tough, durable and aesthetically pleasing finish.

Lydia Frenzel receives the SSPC John D. Keane Award of Merit

Vancouver, WA, March 25, 2015: Lydia Melcher Frenzel, Ph.D., received one of the SSPC (Society of Protective Coatings) highest awards, the John D. Keane Award of Merit, at their Annual Meeting in Las Vegas, on February 3, 2015.

The John D. Keane Award of Merit acknowledges outstanding leadership and significant contributions to the development of the protective coatings industry and to SSPC with awardees being selected by the SSPC Board of Governors.

Dr. Lydia Frenzel is a recognized authority on surface preparation and has co-chaired the SSPC/NACE committees on Water Blasting since 1985. She founded The Advisory Council, an influential network that deals with emerging technologies and their social economic effects. Lydia comes from the Texas Gulf Coast and has seen plenty of rust in action. She earned her doctorate from the University of Texas and accepted a faculty position with the University of New Orleans, where she pioneered marine research at the university with her grants from the Office of Naval Research and the NOAA Sea Grant Program. She is a member of the SSPC Surface Preparation Steering Committee and a member of 12 other SSPC technical committees related to surface preparation, coating application and inspection, plus is a member of the Technical Advisory group at NACE for ISO Surface Preparation Committees TC-35, SC 12 and 14. She received recognition in 2004 as one of 'the most influential persons in the coatings industry' from the JPCL. And lastly she is affectionately known as 'The Water Witch of the West'.

Lydia Frenzel was a plenary speaker and workshop provider to the ACA's conferences in 2002, 2003, 2004, and 2006.

James R. King, Jr., President- SSPC, CEO- John B. Conomos, Inc., presenting the award to Lydia Melcher Frenzel, Ph.D.

APIA changes its name

Since its official rebrand on Wednesday 18 March 2015, The Australian Pipeline Industry Association (APIA) is now known as the Australian Pipelines and Gas Association (APGA).

APGA will remain the peak body representing Australasia's pipeline infrastructure. The new name highlights the organisation's work on gas policy, particularly gas transmission policy, in national debate and discussion.

ACA Welcomes New Members

Corporate Gold

Dehumidification Technologies Pty Ltd
www.rentdh.com

Dehumidification Technologies Pty Ltd, leases humidity and temperature control equipment for the petrochemical and industrial fields. They have the largest variety of desiccant and refrigerant dehumidification equipment to create any environment. Their innovative techniques, wealth of knowledge and dependable service help their customers achieve a successful project - on time and under budget. Their headquarters is in Houston, TX, with 13 other locations in U.S., Canada, Australia and Thailand.

Corporate Bronze

Tranzblast
www.tranzblast.com.au

Tranzblast Coating Services is a proven leader in the abrasive blasting, industrial protective coating industry bringing together over 100 years' experience in the industry. Tranzblast provides expert technical knowledge that varies from basic coating systems to the most complex multi-coat systems, including intumescent fire rated products. Consisting of 6 main sheds totalling over 10,000m² for undercover painting, Tranzblast is one the largest and most competitive blasting and coating service providers in Australia whose state-of-the-art all-weather facility can accommodate any size project. The company employs a skilled workforce whose qualifications include NACE certification and in Quality Control.

Sirocco
Sirocco Industrial has over 30 years' experience in the Oil & Gas, mining, industrial & process sectors utilizing all forms of abrasive & UHP surface preparation. Specialised application of Hot spray polyureas & polyurethanes, Thermal Arc spray coatings to subsea piping, Internal pipe coating with VEG/Flake and standard epoxies. We have a large range of equipment for our yard & site requirements based in Darwin NT.

Contact brett@siroccoind.com.au or PH 08 8932-6566

Brimar
www.brimar.com.au
Brimar is a privately owned Queensland-based electrical contracting company. They have been providing professional and reliable electrical contracting solutions across multiple industry sectors for over 10 years. Their experience has come from their major customers in the areas of government utilities and port facilities. Brimar has a large range of experience in the fields of underground, immersed and in-concrete asset protection. With the experience 'in house' Brimar can provide a complete design, installation and maintenance package with a strong project and facilities management base. Additionally Brimar can provide systems that have complete remote condition monitoring requirements. These systems can be specifically tailored to suit the needs of their customers no matter the type of existing control system.

Linkup Paints (BOP) Ltd
www.l*inkup.co.nz*
www.linkupbop.co.nz

Linkup has been providing coating solutions for over 25 years to the greater Bay of Plenty and Poverty Bay regions of New Zealand. Their experienced and helpful staff can assist with paint, equipment and associated products to the Protective Coatings, Marine and General Industrial markets.

STR INSPECTION SERVICES

QUALITY SYSTEM CERTIFICATION ISO 9001 DNV

JAS-ANZ

Inspection & supervision services made easy

VICTORIAN company STR Inspection Services is uniquely situated to provide a range of inspection and supervision services for major industrial customers.

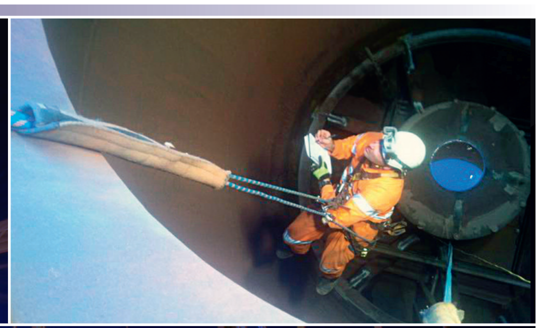
STR Inspection Services staff assist clients with asset management, project quality assurance, welding quality control, welding supervision and weld procedure development.

The company has more than 30 years' experience in industries including oil and gas, pulp and paper, chemical manufacturing, petrochemical, mining, and power generation.

STR Inspection Services is AS/NZS ISO 9001:2008 accredited with DNV-GL in the fields of: asset inspection; AICIP in-service inspection of boilers; pressure equipment and pressure piping; welding supervision and weld procedure development; project quality assurance (QA); and welding quality control (QC).

With STR Inspection Services, clients reap the benefits of outsourcing or supplementing labour for asset inspection or project QA, welding QC and supervision. The company's vast skill set allows client businesses to focus on their core capabilities.

STR Inspection Services provides the required information to satisfy the occupational health and safety authority and relevant codes and standards. Clients can rest assured that all requirements and obligations are delivered to the highest standards.



• Asset Inspection (AICIP – In Service Inspection of Boilers, Pressure Equipment & Pressure Piping) • Welding Supervision & Weld Procedure Development • Project Quality Assurance (QA) • Welding Quality Control (QC)

ph: +61 3 5174 0677 **strinspectionservices.com**

ACA Christchurch Division

Technical Event Report

A technical event and site visit was held at Stark Bros in Lyttelton on Thursday 12 March.

This family owned and operated business has been involved in ship building since 1958.

The vessels include Clinker Dinghy's, Fast Cray Boats, Barges, Steel Tugs, Workboats as well as Timber and Steel Trawlers. Fabrication materials are timber, mild and high tensile steel, stainless steel, aluminium, copper and various other non-ferrous materials.

Ship repair is a major focus for Stark Bros, with their specialist expertise they are able to offer services from afloat maintenance to full dry docking and survey work.

Cameron Stark, Operations Manager, treated the attendees to a tour through the history of ship building at Stark Bros and then allowed the visitors on board both the timber and steel hulls being built at present.

Cameron emphasized the importance of material selection in ship building, not only from a structural perspective but also in terms of corrosion protection. Testing of building material such as steel, is supplier specific, as Stark Bros have learnt over the years that comparing product specifications is not sufficient in predicting material performance in a marine environment.

When asked his opinion on a key learning about corrosion protection in ship building, Cameron delayed his answer until the attendees had full view of the steel hull. According to Cameron, a key learning for Stark Bros, is the difference in performance of shot blasted vs grit blasted steel for the hulls. Coating systems for ship hulls, due to large surface areas constantly being subjected to some form of force, require a proper angular profile for long term adhesion. A rounded shallow profile, achieved through shot blasting the steel surface, could result in early coating delamination, as Stark Bros have experienced on one of their vessels.

Cameron and his ship builder Henry concluded the afternoon's proceeding by treating their visitors to a selection of treats and drinks at which time Graeme Wells from Beca used the opportunity to thank Cameron and his team for their time and generosity. It certainly has been a very valuable learning experience!

FLTR: Cameron Stark (Stark Bros), Graeme Wells (Beca), Vaughan Chaffey and Paul Ratford (Ravensdown).

WA YCG Kick-off event

The Western Australian Young Corrosion Group (WA YCG) was proud to report that their annual kick-off event for 2015 was a success!

The evening was held in the outdoor terrace lounge at Metro Bar and Bistro, which offers a great view of the Perth CBD. The event also doubled as a technical night, offering some valued tips and advice from industry professionals' in **What to do, what not to do, and what really, really not to do when becoming a Project Manager.**

If you work in the corrosion industry, whether it is a small scale office-based job, or managing a large scale mine site construction project; most of us at one stage of our careers will have to manage projects of one kind or another.

Unfortunately, the theoretical portrayal of Project Management that you pick up from University studies and the like doesn't always correlate to what we experience in the real world, where anything can and will try to stop your project from being a success.

For young corrosionists within the industry, you're often "thrown in to the deep end" with supervisor/manager roles, in an attempt to make you "sink or swim". This event aims at introducing project management and its commitments, whilst also outlining the dos and don'ts which will ensure the next project you're managing doesn't end up on the 6:30 edition of *A Current Affair*.

The evening saw 3 short, engaging, and technically relevant presentations from a range of experienced speakers and different backgrounds including: Dr. Andrew Whyte (Curtin University) giving an academics point of view, Mr. David Parravacini (Degremont), and Mr. Wayne Gray (Extrin) giving a consultants point of view. This range of speakers gave a good coverage of the topic, from the theoretical to the practical.

A quick summary of the lessons gleaned from the event are produced in point form below:

- Know your own strengths and weaknesses. Your character type will be suited for leadership or management; these are not the same thing.
- Never let your milestones slip. Get the schedule right from the start, it is human nature to try and achieve it.
- Use the project management tools that are available to you.
- Parkinson's Law; "work expands so as to fill the time available for its completion" – Set the timeline.
- Set the culture at the start (OHSE project, No variations project, Quality project, No horse play project, etc)
- Risk assess the critical path. A good project manager will see the hurdles coming and be ready to jump them when met with them.
- Meetings, meetings and more meetings.
- Assume nothing!
- Make allowances for idiocy, and inadequacy
- "Failing to plan is planning to fail", "A goal without a plan - is just a wish", "If you're not consistently carrying out your plan 90% of the time, you really didn't have a plan at all"
- The 5 P's – Proper Planning Prevents Poor Performance.
- Recognise mistakes, take ownership and learn from them.

Of course, the event wouldn't be complete without a few drinks and food which were kindly provided by the Western Australian Branch of the Australasian Corrosion Association.

WA YCG would like to thank the WA ACA and the ACA for their ongoing support of the young corrosionists and those new to the industry.

WA YCG would also like to thank our speakers for their time and effort as well as all those that attended and made it a great evening

Simon Poggiloi/Extrin

YCG SA 8-Ball Social Night

The ACA YCG SA Branch held their first annual knock out 8 ball competition at Norwood Ballroom Billiard Saloon on 27 March. A great night was had with fierce competition and gourmet pizzas. Congratuations to Huw Dent and Rasool Mayahi on being the top team.

A big thank you to Wattyl Valspar and Dulux Industrial coatings for their support, providing the gifts, drinks and table hire.

ACA Taranaki Division

April Meeting

Pipeline Risk Management – Electrical Hazards and Cathodic Protection

The NZ Branch of the Australasian Corrosion Association (ACA) and the NZ Electrolysis Committee (NZEC) ran this combined technical meeting on Wednesday 29 April, attended by over 30 people from a diverse range of energy companies, from around the North Island.

Jaco Herling (Altex Coatings) MC'd the event, starting by introducing the first talk by Mark Sigley (Corrosion Engineer at Vector) who laid the basis of the later talks with an overview of cathodic protection (CP) implementation and management - as well as threats to integrity and safety from stray current and electrical hazards. Ben Marshall (Electrical Engineer at ITL Engineering) presented a talk on the extremes of CP design, illustrating these with two case studies – the first being a new well-coated, 11km long buried pipeline that required only 1 milliamp of current to be cathodically protected, the other extreme being retrofit to an older, coated offshore oil-rig structure that required 400 amps! Electrical hazards on pipelines were the subject of the final talk by Tony Auditore (Principal Consultant at Linetech Consulting). Tony explained how electrical hazards occur on pipelines and dispelled some of the misconceptions – showing why distribution power lines can pose a significant a risk, similar to or even greater than transmission power lines. Tony presented a case study where an assessment was made of a pipeline affected by 42 power lines and an electrified railway – using the CDEGS software package and risk assessment in line with AS/NZS 4853:2012.

The talks were followed by refreshments, and lively discussions, with many of the attendees taking the opportunity for networking and catching up.

The ACA and the NZEC wish to thank the sponsors for the evening; NZ Corrosion Services and Carboline Coatings.

ACA Auckland Division

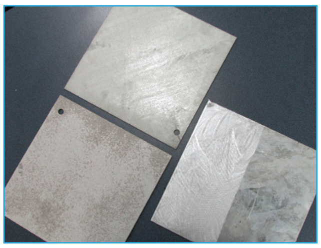
Meeting Report April 2015

On the 29th of April Auckland Division members attended a site visit to *CSP Coatings Systems* in Ellerslie, Auckland. Our host for the evening meeting was Ash Arya, CSP Managing Director. The purpose of the meeting was to hear Ash give a presentation on the subject of '*Duplex Coatings on Galvanized Steelwork*', followed by a visit to the Coatings Division of CSP Coatings. The site meeting was also attended by several members of the Maintenance Engineering Society of NZ (MESNZ).

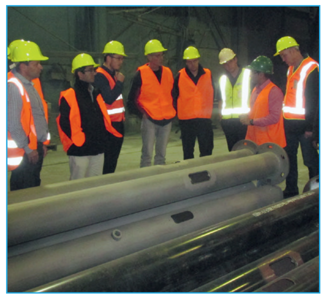
Ash commenced the presentation by outlining the process by which paint coatings can be successfully applied over a galvanized steel element to produce a durable *duplex coating system*. He outlined the necessary surface preparation by *sweep blasting* of hot-dip galvanized steel surfaces to provide a good key for a coating system. Then he described *etch priming* as an alternative way of preparing a hot-dip galvanized steel surface prior to painting. The cost of the two preparation processes is about the same, but Ash favoured the etch priming option at CSP. He then described various paint systems that can be applied over galvanized steel, including epoxy, polyurethane and polyurea coatings. The latter coating is suited to application on galvanized steel street lighting poles for the area of the pole that is installed below ground level. Ash then described how aged hot-dip galvanized surfaces on steelwork could be refurbished.

The attendees then set off on a walk-about of the Painting Division operations at CSP Coatings. Ash explained each job that was in progress in the paint shop (see pictures) and he adeptly answered many questions that the attendees fired at him. The factory visit was followed by a social gathering with refreshments kindly provided by CSP. Ash was then warmly thanked for an interesting presentation and the site visit to CSP Coatings by ACA Auckland Chairman Raed El Sarraf.

Ash Arya presents on Duplex Coatings.



Sweep blasted galvanised steel panel (left) and etch-primed galvanised steel panel (right)



Attendees are shown work in progress at the CSP Coatings Division.

CELEBRATING 60 YEARS • 1955 – 2015 •

60 years on, the ACA still fights the good fight

PART ONE

As our Association starts its seventh decade, it is interesting to reflect on the achievements and advances the ACA has made in the continuing fight to minimise the impact of corrosion.

As we well know, all structures will deteriorate at varying rates over time, depending on the material used, the types of corrosive agents in the environment and the physical processes and mechanisms involved. The cost of corrosion is still estimated at between 3 and 5 per cent of GDP, but as the global economy continues to grow, more and more infrastructure—domestic and commercial buildings, roads, bridges, pipelines, etc.—is being built, so the actual monetary cost is increasing.

In 1955, the founders of the Association recognised that corrosion would only be beaten through coordinated efforts and so accepted the challenge of bringing industry and academia together to study the causes and remedies of all forms of corrosion.

To mark the start of our 60th Anniversary commemorations, we are publishing a speech given by Milton Speedie, the then President of the Association, in 1957. On some level, when reading the speech, you could feel that maybe nothing has changed, but his words should make you feel emboldened to continue meeting the challenges posed by corrosion. Speedie was certainly correct in his assertion that technological change was advancing geometrically: as he predicted, there have been amazing scientific and industrial developments since the ACA was formed, but new materials and production methods mean that new types of corrosion need to be studied and controlled.

The Association has been, and continues to be, a hub for discourse and discussion on all aspects of corrosion and its impact. Since its foundation, the ACA has also provided a link for corrosion workers in Australia and New Zealand to their counterparts around the world.

In the coming months, we will be publishing articles about some of the advances in the technology of corrosion control and interviews with some of the elder statesmen and doyens of our industry.

The story of the ACA is the story of dedicated, talented people, who, for more than 60 years, have risen to the challenges of corrosion and exceeded expectations of what is possible.

Today we recognise their achievements, but also that there are further challenges ahead. Our industry may meet these in surprising ways, but, to paraphrase Al Jolson, "You ain't seen nothin' yet..."

The Future of the Australian Association of Corrosion Prevention

MELBOURNE BRANCH PRESIDENTIAL ADDRESS

Delivered by Milton G. Speedie, M.C.E., M.I.E.Aust., on 12th March 1957.

In presenting my address I first want to express my deep appreciation of our Committee men, and the other members of the Association who have served on special committees, for the good work done during the year on behalf of the Association and for the assistance I have personally received. As you will see from the Annual Report, the work of the Association has progressed substantially during the past session.

Tonight I have decided to keep away from technical matters and confine my remarks to a few observations on subjects which I feel are of importance to the Association's future. It is always wise to stop occasionally and consider where we are–or should be–heading.

This Association has a limited canvas when considered in relation to technology as a whole. However, it is one of importance as was well illustrated by Professor Worner when he informed the 1955 Symposium on Corrosion that corrosion is costing Australia more than £100 million per annum. A little consideration shows that this represents more than ten shillings per week out of every wage and salary envelope. Further, it has been said that of every £10 spent by a farmer on repair and replacement to machinery £4 is attributable to corrosion. Corrosion thus has an appreciable bearing on the standard of living of this community and the cost is still higher in more developed countries, such as U.S.A. It can be a substantial factor in national finances when a country imports large quantities of corrodible products.

Its economic importance resulted inevitably from the industrial development of the 20th century wherein the reduced cost of steel production led to that metal becoming the primary constructional material. Although new materials are from time to time put into use, there is no reduction in the quantity of steel. Quite the reverse; steel consumption is rapidly increasing so that the cost of corrosion per head of population must continue to increase correspondingly.

The technological developments of the last 50 years have been remarkable, and have probably equalled those of the whole previous history of man on earth–a hundred thousand or more years of effort–yet there is reason to believe that it will not take us anywhere near another 50 years to make such progress again. We are accelerating geometrically not arithmetically.

Current developments include new sources of fuel and power, new metals and materials, new chemicals and medicines, new machines and processes, new means of travel and transport, and new methods of calculation, control and communication. It is a momentous age in which the importance and impact of automation should not be overlooked. All these developments will bring their difficulties. There will be many new corrosion environments and a large variety of new problems can be expected. But there will also be new knowledge and new protective materials with which to combat corrosion.

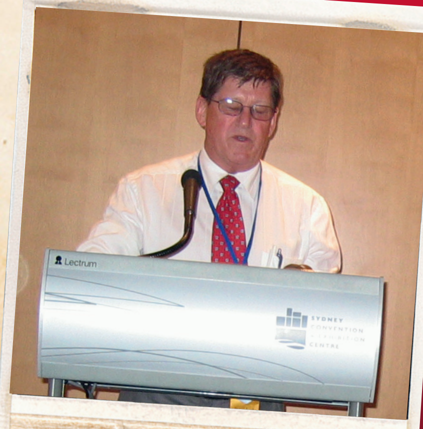
Corrosion is a natural phenomenon which cannot be prevented, but a large amount of control is possible. In this respect there is a similarity to soil erosion control which slows down erosion until it becomes imperceptible during a person's lifetime, but does not prevent denudation of countryside in geological periods.

Continued over…

WILLIE MANDENO & BRIAN CHERRY STARTING CONFERENCE CLOCK AT C&P08

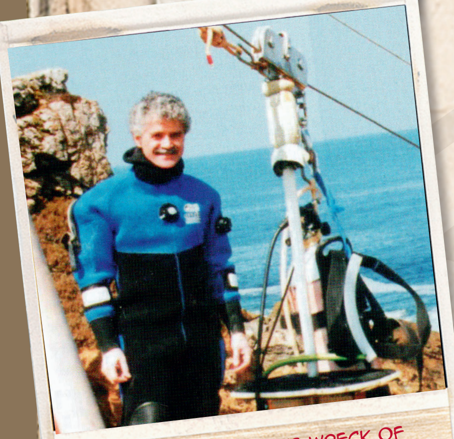
IAN MACLEOD SPREADING NaOH PELLETS ON THE XANTHO ENGINE IN 1990.

WILLIE IN A RUSTY WRECK



FRED SALOME AT C&P07

WILLIE MANDENO HANDING OVER PRESIDENCY TO BRIAN MARTIN AT C&P01



IAN MACLEOD ABOVE THE WRECK OF THE SAN PEDRO DE ALCANTARA (1786) NEAR PENICHE IN PORTUGAL IN 1996

C&P 2004

IAN MACLEOD RECORDING CORROSION PARAMETERS ON THE WRECK OF AN "EMILY" BOMBER, CHUUK LAGOON, FEDERATED STATES OF MICRONESIA IN 2006

It seems to me that the formation of an Association dedicated to the mitigation and control of corrosion was a logical step at the present stage of scientific and industrial development, for it is necessary to increase and accelerate the contribution which corrosion technology can make to the progress of mankind. It will bring closer the scientist, research worker, metallurgist and engineer, so enhancing the efficiency of each in applying his art to the benefit of man.

We all tend to lag behind in the appreciation of the changes that have taken place, or are taking place, around us. Even though we try to keep up with the trend of events we are frequently left with a feeling of wonder on the realization of a new aspect of development. Consequently there is no need for me to stress the value of an Association such as this which provides a forum for free discussion of all aspects of corrosion technology, and so enables those interested to more readily receive, assimilate, and assess the value of, new knowledge and developments.

Since World War II the public has realized the value of research and technological advancement. It probably took the atom bomb to do this. Now the man in the street is looking more and more to the scientist and engineer not only to enhance his mode of living but also to secure the future of the nation. It is expected that technically trained people will in future take an increasingly important place in the direction of nations and the control of man's welfare. All scientific people and bodies thus share a great responsibility and must face the challenge and strive for progress in every field-both as individuals and collectively.

Today there is widespread interest in research which is in contrast to the general attitude a few years ago. At this time last year our retiring President in his address gave an excellent resume of the development of corrosion research and knowledge. It was fitting that our attention should be drawn to those first steps in this subject and that he should trace their growth and development. It was mainly a story of individual effort which succeeded in spite of lack of facilities and the disinterest of others. Today conditions are very different with large resources backing research. However, the need for personal effort will always remain, and by remembering the brilliant peaks of those past endeavours we may be encouraged to dedicate ourselves to the tasks of the present and face the challenge of the future.

What is the challenge facing the Association today? Doubtless many of you could express it more eloquently than I, but I will attempt to give you a few thoughts and hope that as members and committees you will consider what steps we should take. A group of people would develop this line of thought more effectively and it is hoped that members will make suggestions.

The aim of the Association is to increase the awareness of the extent of damage caused by corrosion, to assist those interested, to study corrosion and its mitigation, and to bridge the gap between the user and supplier of corrosion preventatives. The ideal is to secure as members every engineer, scientist, user, supplier and person involved in any way by corrosion and bring them together for a better understanding of the principles and practice of corrosion prevention. Although the number of ordinary members of the Association increased by 65 per cent last year, the field is vast and a greater rate of increase could be attained.

We should strive not only towards the development of scientific knowledge but what is more important at present in my view, is the need to stimulate continual improvement in the education of engineers and others responsible for structures, equipment and plant of all kinds; so leading to a better standard and wider scope of corrosion protection. As previously indicated, I consider it important that the cost of corrosion be appreciated and also that the most costly types of failure be given publicity. The study of failures provides a most valuable avenue for reducing cost by avoiding repetition.

Why is it that so few engineers and architects attend our meetings, and the educational institutions are not adequately represented? As an engineer I am conscious that the members of my profession are inadequately informed in regard to corrosion. I also realize that they must keep abreast of many avenues of knowledge and therefore a minimum of time is available to each. This Association should do its utmost to help the engineer acquire appropriate knowledge with a minimum of effort.

THE AMALGAMATION OF BRANCHES IN AUSTRALIA (VIC, NSW & QLD) AND CORROSION PREVENTION ASSOCIATION IN NEW ZEALAND, TO FORM THE AUSTRALASIAN CORROSION ASSOCIATION – OCCURRED IN NOVEMBER 1960.

In our democratic community we do not have a dictator to ensure that technical people take an interest in our proceedings, consequently we must develop attractive and effective methods of disseminating information which will appeal to the average designer. Methods geared to prewar world requirements would naturally be inadequate in a post-war world. In the same way, but to a lesser extent, what was satisfactory in 1956 will not be adequate in 1957. This is a challenge to the new Committee.

We must not be an isolationist Association. Our relationship with professional and business bodies and the public deserves study and appropriate liaison should be developed. Also the work of the Association should be advertised as widely as possible. Our new President has led in this regard by bringing the Association to public notice on a number of occasions.-

The Association through its committees is endeavouring to assist Government Authorities and Industry with their problems. It is neither practicable nor desirable for the problems to be solved by Association members, but guidance and assistance can be given, such as advising suitable consultants or suggesting the source of required information. Each authority or group can thus be assisted to adapt itself to present conditions and to take advantage of new developments.

Today there are many new and comparatively untried protective materials and the user finds it practically impossible to determine with any certainty the life and usefulness of each, so there is a great need for the development of reliable accelerated test or tests. The Association may be able to assist in this regard and it should foster the gathering and systematization of records and experience, together with the comparison of methods under field conditions.

It should also stimulate research and large scale field experiments. In future I trust it will be possible for the Association to have a Research Committee which will chart fields where information is required, propose specific projects, and although it will not finance research it may be possible to arrange for the financing of needed work.

The corrosion of concrete and other materials is also of importance and deserves consideration along with metallic corrosion. The need for more technical knowledge and technically trained personnel is obvious but, as I inferred earlier in this address, the needs do not stop there. It is also generally acknowledged that we need more philosophers–more philosophic thinking–if we are to enjoy and benefit from more efficient processes and the greater leisure obtainable in the near future. What can we as individuals and an Association do in this regard?

I am of the opinion that scientifically trained people should take their full share of community work by giving their time and talents to the many committees encountered in everyday life. The tendency is to avoid such responsibilities as the result of many commitments to technical bodies such as this Association.

The challenge that faces us thus has several sides and confronts not only our committee but every member. We should all strive to infuse more vigour and vitality into the Association, advertise it to all to whom we come in contact and do our utmost to interest those involved in corrosion to the point of affiliating with us. Further, there is the element of service to our fellow men.

In this address I have given you an ideal, well knowing that an ideal is something unobtainable. However, we can always keep advancing towards it and strive to approach it as closely as possible. So let us steer by the stars and although we may never reach them, we will be the better for the trying.

CTI CONSULTANTS DINNER AT 1998 CONFERENCE. VISIBLE ARE DON BARTLETT, HOWARD MORRIS, CAROL BODLE, FRED SALOME, JOHN BROOMFIELD & BILL MCEWAN

HOBART CONFERENCE TOURISTS AT THE TOP OF MT. WELLINGTON. HOWARD MORRIS, ED POTTER & BILL MCEWAN

If you would like to contribute to the 60th Anniversary story series please contact Tracey Winn at twinn@corrosion.com.au

NEW PRODUCT SHOWCASE

The ACA does not officially endorse any of the products advertised in *Corrosion & Materials.*

Morgan Advanced Materials materials for heat shields

Morgan Advanced Materials announces the availability of materials for heat shields for highly demanding environments in industrial applications like iron and steel and transportation applications such as aerospace, marine and automotive.

Materials for heat shields range from high temperature ceramic fibre materials to microporous insulation, allowing them to be customised to each customer's unique application needs. The benefits provided by these high temperature insulation materials include exceptional durability, low thermal conductivity, and light weight, all while maintaining high standards of product performance.

Heat shields manufactured by Morgan are available as shell, flexible, rigid box, or integrated technology, allowing engineers to best fit products to an application's specific needs. The heat shields core materials range from low bio-persistent Superwool® fibre and Denka Polycrystalline fibre, to Min-K® or WDS® microporous insulation.

The physical and thermal properties of these materials are maintained with any selected custom encapsulation. Morgan's engineering team works with customers to identify and develop a solution for each heat shield application, with temperature classifications up to 1,370°C.

All encapsulation materials used in Morgan's heat shields are proven successful as thermal barriers in real-world applications. In industrial applications where access for maintenance may be required, like exhaust manifolds or valve and pipe fittings, flexible and shell technologies offer ideal solutions. The same flexible and shell technologies are also ideal for aerospace thrust reverser and automotive catalytic converter applications.

The flexible encapsulation solution provides a fully flexible, lightweight jacket that is easy to fit to intricate shapes and remove as required. Shell technology, comprised of a stainless steel encapsulation heat shield, is slim, easy to fit, and easy to remove, making them perfect for applications where preventing contact with the encapsulated material is preferred.

For further information visit www.morganthermalceramics.com/products/heat-shields.

Rhino Linings limit leaks

A Rhino Linings high-pressure, plural component, spray machine on a travel pallet, with drums in bunded sections to contain minor spills.

Failing expansion joint seals in the floor of a water storage tank.

The water tank floor showing repaired seals between concrete segments and between the steel walls and ring beam.

Corrosion of water industry infrastructure costs in excess of $1B each year. One method of refurbishment of water industry assets most affected by corrosion, such as pipelines, storage tanks and treatment plants, is to carry out surface repairs and then apply protective coatings.

Based on the Gold Coast, Rhino Linings Australasia sources all its materials from local suppliers except for some very specialised chemicals which are imported from the parent company in America. Being a local manufacturer allows the company to be more responsive to customer requests.

Unlikely to have Uni query sorted today they are notoriously bad respondersWhen refurbishing or repairing any pipes, channels or tanks that carry potable water, special coatings are required as it is essential that no chemicals leach into the drinking water. The structure of the polymer used for wastewater and sewerage treatment infrastructure, such as clarifier tanks and sewage channels, needs to be resistant to abrasion and chemical attack. Rhino Linings coatings are regularly tested for compliance with the latest version of AS4020 at the Australian Water Quality Centre in Adelaide.

The Rhino Linings Polyurethane and Pure Polyurea coatings have a patented mix ratio that has been determined over many years. The company's coatings contain no solvents or volatile organic compounds. High build polymer coatings are also flexible which allows them to stretch and shrink as substrates expand and contract due to temperature and ground fluctuations.

Accessibility to a project site is an important planning issue. Rhino Linings Australasia assists its dealers in developing best method procedures and practices for transporting chemicals and machinery to site.

For further information, please visit the website: www.rhinolinings.com.au or contact:

Michelle Gunn
Telephone: +61 (07) 5585 7000
E-Mail: info@rhinolinings.com.au

New Elcometer Corrosion Under Insulation Detector

Pipeline failure through corrosion under insulation causes supply shortfalls, economic loss and environmental pollution.

Early detection of the presence of moisture significantly reduces the risk of corrosion developing underneath the pipes insulation.

Ideal for use in the Oil, Gas and Power Generation Industries both on or off shore. These detectors are easy to fit in new or existing installations. They can be fitted where flammable gasses and vapour groups IIA, AAB and AAC may be present.

Features:

- Suitable for new or existing installations on or off shore
- 5 year service life
- High Visibility fluorescent orange float provides failsafe detection of liquid or water
- High Intensity flashing LED visual alarm
- Does not interfere with thermal properties of insulation'
- Detachable sample vial can be sent away for analysis of contents
- Works in extreme temperatures -40°C to +180°C on pipework at +180°C
- Intrinsically safe
- External dust and water resistant rugged design equivalent to IP66

The Elcometer 1001 CUI detects and identifies the location of any fluid leak on thermally insulated pipes, 24 hours a day, 365 days of the year, preventing corrosion and reducing unplanned repair and maintenance costs.

For further information contact Phillro Industries on 1300 503 610 or Email sales@phillro.com.au

Protective Coatings Preventing Corrosion

19 March 2015

Adelaide

SPONSORED BY:
galvanizers ASSOCIATION OF AUSTRALIA
International

PROUDLY PRESENTED BY:
AUSTRALASIAN CORROSION ASSOCIATION INC.

The Coatings Technical Group of the ACA held a technical event on Thursday 19 March at the Mercure Grosvenor Hotel in Adelaide.

This full day technical event had 45 delegates from a broad cross section of the industry in attendance. The event brought a range of industry experts together to share their knowledge and investigate ways to better improve the longevity of protective coatings in a variety of applications and environments. There was also a session on the recently released AS/NZS 2312.1 – Paint Coatings & AS/NZS 2312.2 – Hot Dip Galvanizing. At the conclusion of the event an open floor forum was held and chaired by Alex Shepherd, which provided much discussion on the issues within the industry.

The ACA would like to thank all speakers, sponsors and delegates who attended this event and for making the day a huge success!

Below is an overview and summary of the presentations provided by the speakers:

Compliance of Structural Steel Fire Protection with Intumescent Coatings

Chris Partington, International Paint

The ever-increasing use of steel as a construction material has led to enhanced flexibility in design, as well as significant time savings in the construction industry. However, its use in social infrastructure and buildings has brought an additional challenge - that of fire safety. In the event of a fire, steel can lose its strength and collapse, resulting in damage to property and in the worst case, loss of life.

Almost all buildings incorporate some fire safety measures. In the event of a fire, structures are required to maintain their stability for a reasonable period of time to enable occupants to evacuate and to provide safety to fire-fighters. There are numerous products available to designers to satisfy the fire resistance requirements of their projects. Understanding passive fire protection technology and the impact of legislation is important to ensure compliance with standards for fire and life safety.

Intumescent coatings provide a cost effective and environmentally method to protect structural steelwork, compared to other traditional methods such as vermiculite spray.

As with any fire protection product, it is important to understand its basis to ensure correct specification and one that is fit for purpose. This presentation outlined some of the key issues that architects, engineers, fabricators, applicators and Approving Authorities should be aware of when dealing with intumescent coatings with the intention of raising awareness and providing an increased level of understanding with intumescent coating technology. Intumescent technology was described together with key issues relating to structural response, fire types, fire resistance ratings, anti-corrosion performance, specification, certification schemes, application and maintenance, along with an introduction to the new good practice guide for Intumescent coatings.

Specifications for Corrosion Management Using Coatings – Does It Have To Be So Complicated?

Dennis Richards, DM Richards Consulting Services

Bridges are an integral part of any transport network and are critical to delivering primary and secondary products to the market. The maintenance of bridges is important in terms of preserving the design durability for the longest possible term, thereby minimising the cost to road users.

The management of corrosion using coatings is often the most viable option available to structure managers but can also carry some risk of premature failure if not well designed and executed. The aim of a coating specification is to address all variables which will impact on the durability outcome, and as such must be prescriptive. A robust specification will identify what elements need to be addressed, how they will be measured and the measurement limits which will ensure optimum durability. The issues surrounding inspection and surveillance should also be investigated.

This presentation placed a number of key parameters under the microscope and suggested ways in which these parameters can be controlled to maximum effect.

Considerations When Selecting Long Term Protective Coatings

David Towns, Denso Australia

When selecting long term protective coatings it is important to understand and accept the boundaries that are out of our control. Shareholders, directors and accountants decide what will be used on a structure to keep it in service. Our job is to fit into the scope of their requirements. This presentation discussed the need for Life Cycle cost analysis. There is no doubt that there will always be critical maintenance and that will always be the preference for the majority of operational expenditure.

Traditional coatings are generally associated with the old blast and paint approach, which can be quick, can be cheap, can last a long time, but can fail very quickly. As the cost is the most important variable, jobs can be done inadequately. You get what you pay for. There are other options. Combinations of long term systems and research and development, is what makes old companies last a long time. It is important to adapt to the times and to the environment. Latest technology scares most old school engineers and those that have not done their homework properly. David's presentation outlined some of these new technologies and reminded us to always investigate new solutions.

Coating Selection and Performance in Water Industry Applications

Danny London, SA Water

This presentation outlined the process used by SA Water to develop coating, wrapping and lining specifications which are referenced in project specifications and available to all SA Water asset management and maintenance staff. The presentation outlined the coating and wrapping environmental testing programs used for over 40 years by SA Water to obtain in field performance data that influences the content of the technical specifications. Other inputs to the specifications were also discussed. Finally the presentation outlined 3 recent projects involving coatings selection and testing and an investigation into the performance of mild steel cement lined pipe spools. Lessons learnt from these projects were also discussed.

A Guide to AS/NZS2312.1 (2014) Paint Coatings – What Is It & Why You Need To Tell Your Customers About It

Kingsley Brown, Incospec & Associates

Australian/ New Zealand Standard AS/NZS 2312 provides guidelines for selection and specification of coating systems for corrosion protection of structural steelwork. It is arguably the most important Australian standard on corrosion protection, being the main guide for coating specifiers in this part of the world since its predecessor first appeared in 1967. It has recently undergone a major update. The new AS/NZS 2312 Part 1 on paint coatings has been updated and edited including new information on diverse subjects such as warranties, fabrication defects, recommended coating systems, maintenance and inspection. The presentation outlined the changes to this vital Standard.

A Guide to AS/NZS2312.2 (2014) Hot Dip Galvanizing – What Is It & Why You Need To Tell Your Customers About It

Peter Golding, Galvanizers Association of Australia

Early in the review process of AS/NZS 2312:2002, Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings, it was recognised that steel designers would benefit by separating the Standard into product specific sections to avoid confusion. The revised Standard was released in December 2014; with Part 1 covering paint systems and Part 2 covering hot dip galvanizing (HDG). Both new parts to the Standard use the same definitions from AS 4312 for corrosivity categories in Australia, but now clearly recognise that the design process and durability of the two products are very different.

Designers wishing to specify HDG need only use two Standards; one covering the design and durability of HDG steel (AS/NZS 2312.2), and the other dealing with the manufacturing process and tolerances (AS/NZS 4680). This presentation provided an introduction to the key features of the hot dip galvanizing component (Part 2) of AS/NZS 2312. The presentation showed how the new Standard will allow designers to more accurately estimate the durability of HDG coatings and illustrate good design practice. In addition, the presentation provided design advice for duplex coatings and explained the effect of the steel chemistry on the final coated product.

Don't Get Yourself In A Sticky Situation – Test Results For Glues Used For Adhesion Testing To AS3894.9 Method C

Kingsley Brown, Incospec & Associates

After specifying, conducting, interpreting and reviewing a significant number of adhesion pull off test results for clients there are many times where adhesive failures have led to a good result not being obtained. Adhesion testing is normally a two day exercise involving day one gluing the dollies, waiting overnight for the glue to dry, then returning the following day to pull the dollies and reporting. When done in the field on assets in remote locations the 24 hour cure time adds significant cost to the testing due to inspector wages, accommodation and travel costs. This presentation outlined that this created the need for further investigation and the start of writing a technical paper. The paper and experimentation looked at the pull off values of a range of 8 readily available glues which were pulled at set time intervals in search of a product which provided reliable results in the shortest period of time. The overall aim to find the right glue to achieve the pass/fail adhesion criteria required for a coating system that could conducted in a single day minimising any null results (i.e. a glue failure below the pass fail criteria)

When It All Goes Wrong.. What Next? – Coatings Issues in the Oil & Gas Sector

Roman Dankiw

The consequences of coating failures vary considerably, from a minor touch up repair to complex and high risk repair work on high pressure equipment, sometimes on-line. This presentation focussed on some coating issues in the Oil and Gas sector with significant consequences, resulting in advanced NDT and welding/repair methods employed to minimise the safety and financial impact on the asset owner.

ACA Standards Update

Welcome to the third corrosion related standards report for 2015.
The standards reporting for 2015 is scheduled against Technical Groups (TG) as indicated below:

Issue 2015	Standards search for TG interests	Issue 2015	Standards search for TG interests
Feb	Concrete Structures & Buildings	**August**	Cathodic Protection
April	Coatings	**October**	Mining Industry
June	Petroleum & Chemical Process Industries	**December**	Water & Waste Water

This Standards report focuses on the Petroleum & Chemical Process Industries technical group.

As previously this report is in two stages, namely:

Stage 1
A global standards and publication focus, searching through SAIGLOBAL Publications at https://infostore.saiglobal.com/store, for all current publications and standards relating to one of the ACA technical Groups, with this editions group focus being the '**Petroleum & Chemical Processing Industries**' Technical Group.

This proved to be quite difficult given the general title of the Technical group. Different search strategies were used, as shown in the results.

Stage 2
A SAI Global search, as previously, at http://www.saiglobal.com/online/ for new standards, amendments or drafts for AS, AS/NZS, EN, ANSI, ASTM, BSI, DIN, ETSI, JSA, NSAI and standards and amendments for ISO & IEC published from **16 March 2015 to**
17 May 2015, using the key words and key word groups:

- 'durability'.
- 'corrosion' or 'corrosivity' or 'corrosive'; but not 'anodizing' or 'anodize(d)'.
- 'paint' or 'coating'; but not 'anodizing' or 'anodize(d)'.
- 'galvanize' or 'galvanized' or galvanizing'.
- 'electrochemical' or 'electrolysis' or 'electroplated'.
- 'cathode' or 'cathodic'.
- 'anode' or 'anodic'.
- 'corrosion' and 'concrete' or 'concrete' and 'coatings'.

Summary
Stage 1 Report
Through SAIGLOBAL Publications at https://infostore.saiglobal.com/store there were:

a. For "Petroleum & Corrosion" there were 116 Titles (2 more than this time last year), none from AS/ASNZS, 3 from ASTM, 7 from ISO and 4 from NACE as shown in Table 1 below.

b. For Titles search 'Gas and Corrosion'; result 171 Titles (5 less than this time last year); the titles included 2 from AS/ASNZS, 6 from ASTM, 9 from ISO and 6 from NACE; there were titles repeated from the "petroleum & corrosion" search above; ; as shown in Table 2 below.

c. For Titles search 'Chemical and Corrosion"; result 127 Titles (2 more than this time last year); 1 from AS/ASNZS; 8 from ASTM, 6 from ISO and 5 from NACE; as shown in Table 3 below.

Stage 2 Report
Across SAIGLOBAL online Standards Publications there was a total of 33 listings of new standards, Drafts and Amendments, found issued from to 16 March 2015 to 17 May 2015; with 0 from AS AS/ASNZS; as shown in Table 4 below.

Reader feedback and interaction is welcomed to enable focus improvement and better minimisation of corrosion.

Stage 1 Report
Report on SAIGLOBAL Publications at https://infostore.saiglobal.com/store, for all current publications and standards relating to "petroleum or gas and corrosion" for the "Petroleum & Chemical Processing Industries" Technical Group.

Table 1
For Titles search 'Petroleum and Corrosion"; result 116 Titles (2 more than this time last year), none from AS/ASNZS, 3 from ASTM, 7 from ISO and 4 from NACE.

ASTM D130 ADJUNCT	Adjunct to D130 Copper Strip Corrosion Standard for Petroleum
ASTM D1838-14	Standard Test Method for Copper Strip Corrosion by Liquefied Petroleum (LP) Gases
ASTM D7548-09	Standard Test Method for Determination of Accelerated Iron Corrosion in Petroleum Products
ISO 13680:2010	Petroleum and natural gas industries - Corrosion-resistant alloy seamless tubes for use as casing, tubing and coupling stock - Technical delivery conditions
ISO 15156-3:2009	Petroleum and natural gas industries - Materials for use in H_2S-containing environments in oil and gas production - Part 3: Cracking-resistant CRAs (corrosion-resistant alloys) and other alloys
ISO 21457:2010	Petroleum, petrochemical and natural gas industries - Materials selection and corrosion control for oil and gas production systems

ISO 4404-1:2012	Petroleum and related products - Determination of the corrosion resistance of fire-resistant hydraulic fluids - Part 1: Water-containing fluids
ISO 4404-2:2010	Petroleum and related products - Determination of the corrosion resistance of fire-resistant hydraulic fluids - Part 2: Non-aqueous fluids
ISO/FDIS 15156-3	Petroleum and natural gas industries - Materials for use in H_2S-containing environments in oil and gas production - Part 3: Cracking-resistant CRAs (corrosion-resistant alloys) and other alloys
ISO/DIS 13680	Petroleum and natural gas industries - Corrosion-resistant alloy seamless tubes for use as casing, tubing and coupling stock - Technical delivery conditions
NACE 34103:2014	Overview of Sulfidation (Sulfidic) Corrosion in Petroleum Refining Hydroprocessing Units
NACE SP 01 76:2007	Corrosion Control of Submerged Areas of Permanently Installed Steel Offshore Structures Associated with Petroleum Production
NACE SP 02 08:2008	Internal Corrosion Direct Assessment Methodology for Liquid Petroleum Pipelines
NACE MR 0175 ISO 15156:2009	Petroleum and Natural Gas Industries - Materials for use In H[2]S-Containing Environments in Oil and Gas Production - Part 1: General Principles for Selection of Cracking-Resistant Materials - Part 2: Cracking-Resistant Carbon and Low-Alloy Steels, and the use of Cast Irons - Part 3: Cracking-Resistant CRAs (Corrosion-Resistant Alloys) and Other Alloys

Table 2
For Titles search 'Gas and Corrosion"; result 171 Titles (5 less than this time last year); the titles included 2 from AS/ASNZS, 6 from ASTM, 9 from ISO and 6 from NACE; there were titles repeated from the "petroleum & corrosion" search above.

AS 60068.2.60-2003	Environmental testing - Tests - Test Ke: Flowing mixed gas corrosion test Standards Australia; Referenced in Codes of Practice - Access CodeConnect Standards Australia
AS/NZS ISO/IEC 24702:2007	Telecommunications installations - Generic cabling - Industrial premises Standards Australia
ASTM D1838-14	Standard Test Method for Copper Strip Corrosion by Liquefied Petroleum (LP) Gases
ASTM F363-99(2011)	Standard Test Method for Corrosion Testing of Gaskets
ASTM G186-05(2011)	Standard Test Method for Determining Whether Gas-Leak-Detector Fluid Solutions Can Cause Stress Corrosion Cracking of Brass Alloys
ASTM B845-97(2013)e1	Standard Guide for Mixed Flowing Gas (MFG) Tests for Electrical Contacts
ASTM A732/A732M-14	Standard Specification for Castings, Investment, Carbon and Low Alloy Steel for General Application, and Cobalt Alloy for High Strength at Elevated Temperatures
ASTM B827-05(2014)	Standard Practice for Conducting Mixed Flowing Gas (MFG) Environmental Tests
ISO 10062:2006	Corrosion tests in artificial atmosphere at very low concentrations of polluting gas(es)
ISO 15156-3:2009	Petroleum and natural gas industries - Materials for use in H_2S-containing environments in oil and gas production - Part 3: Cracking-resistant CRAs (corrosion-resistant alloys) and other alloys
ISO 21457:2010	Petroleum, petrochemical and natural gas industries - Materials selection and corrosion control for oil and gas production systems
ISO/FDIS 15156-3	Petroleum and natural gas industries - Materials for use in H_2S-containing environments in oil and gas production - Part 3: Cracking-resistant CRAs (corrosion-resistant alloys) and other alloys
ISO 13680:2010	Petroleum and natural gas industries - Corrosion-resistant alloy seamless tubes for use as casing, tubing and coupling stock - Technical delivery conditions
ISO 21207:2004/Cor 1:2008	Corrosion tests in artificial atmospheres - Accelerated corrosion tests involving alternate exposure to corrosion-promoting gases, neutral salt-spray and drying - Technical Corrigendum 1
ISO 21207:2004	Corrosion tests in artificial atmospheres - Accelerated corrosion tests involving alternate exposure to corrosion-promoting gases, neutral salt-spray and drying
ISO/DIS 13680	Petroleum and natural gas industries - Corrosion-resistant alloy seamless tubes for use as casing, tubing and coupling stock - Technical delivery conditions
ISO 8092-2:2005	Road vehicles - Connections for on-board electrical wiring harnesses - Part 2: Definitions, test methods and general performance requirements
NACE 61114:2014	Underdeposit Corrosion (UDC) Testing and Mitigation Methods in The Oil and Gas Industry
NACE 1C187:2005	Use of Galvanic Probe Corrosion Monitors in Oil and Gas Drilling and Production Operations
NACE SP 01 10:2010	Wet Gas Internal Corrosion Direct Assessment Methodology for Pipelines

NACE SP 01 92:2012	Monitoring Corrosion in Oil and Gas Production with Iron Counts
NACE SP 02 06:2006	Internal Corrosion Direct Assessment Methodology for Pipelines Carrying Normally Dry Natural Gas (dg-icda)
NACE MR 0175 ISO 15156:2009	Petroleum and Natural Gas Industries - Materials for use In H[2]S-Containing Environments in Oil and Gas Production - Part 1: General Principles for Selection of Cracking-Resistant Materials - Part 2: Cracking-Resistant Carbon and Low-Alloy Steels, and The Use of Cast Irons - Part 3: Cracking-Resistant CRAs (Corrosion-Resistant Alloys) and Other Alloys

Table 3
For Titles search 'Chemical and Corrosion"; result 127 Titles (2 more than this time last year); 1 from AS/ASNZS; 8 from ASTM, 6 from ISO and 5 from NACE.

AS 2331.3.11-2004	Methods of test for metallic and related coatings - Corrosion and related property tests - Chemical residue tests
ASTM F1111-08b(2013)	Standard Test Method for Corrosion of Low-Embrittling Cadmium Plate by Aircraft Maintenance Chemicals
ASTM F482-09(2014)	Standard Practice for Corrosion of Aircraft Metals by Total Immersion in Maintenance Chemicals
ASTM F483-09(2014)	Standard Practice for Total Immersion Corrosion Test for Aircraft Maintenance Chemicals
ASTM G109-07(2013)	Standard Test Method for Determining Effects of Chemical Admixtures on Corrosion of Embedded Steel Reinforcement in Concrete Exposed to Chloride Environments
ASTM G157-98(2013)	Standard Guide for Evaluating Corrosion Properties of Wrought Iron- and Nickel-Based Corrosion Resistant Alloys for Chemical Process Industries
ASTM D7973-14	Standard Guide for Monitoring Failure Mode Progression in Plain Bearings
ASTM C1423-14	Standard Guide for Selecting Jacketing Materials for Thermal Insulation
ASTM C1729-14a	Standard Specification for Aluminum Jacketing for Insulation
ISO 28706-1:2008	Vitreous and porcelain enamels - Determination of resistance to chemical corrosion - Part 1: Determination of resistance to chemical corrosion by acids at room temperature
ISO 28706-2:2008	Vitreous and porcelain enamels - Determination of resistance to chemical corrosion - Part 2: Determination of resistance to chemical corrosion by boiling acids, boiling neutral liquids and/or their vapours
ISO 28706-3:2008	Vitreous and porcelain enamels - Determination of resistance to chemical corrosion - Part 3: Determination of resistance to chemical corrosion by alkaline liquids using a hexagonal vessel
ISO 28706-4:2008	Vitreous and porcelain enamels - Determination of resistance to chemical corrosion - Part 4: Determination of resistance to chemical corrosion by alkaline liquids using a cylindrical vessel
ISO 28706-5:2010	Vitreous and porcelain enamels - Determination of resistance to chemical corrosion - Part 5: Determination of resistance to chemical corrosion in closed systems
ISO 28765:2008	Vitreous and porcelain enamels - Design of bolted steel tanks for the storage or treatment of water or municipal or industrial effluents and sludges
NACE SP 01 95:1995 (R2007)	Corrosion Control of Sucker Rods By Chemical Treatment
NACE TM 01 93:2000	Laboratory Corrosion Testing Of Metals in Static Chemical Cleaning Solutions at Temperatures Below 93°C (200°F)
NACE 42102:2002	Corrosion in Power and Communication Manholes
NACE RP 03 04:2004	Design, Installation, and Operation Of Thermoplastic Liners for Oilfield Pipelines
NACE SP 01 92:2012	Monitoring Corrosion in Oil and Gas Production with Iron Counts

To access these publications, go to https://infostore.saiglobal.com/store and type 'coatings and corrosion' into the search box and examine the search results.

Stage 2 Report

Table 4
STANDARDS FOR AS, AS/NZS, EN, ANSI, ASTM, BSI, DIN, ETSI, JSA, NSAI AND STANDARDS AND AMENDMENTS FOR ISO & IEC PUBLISHED from 16 March 2015 to 17 May 2015 for:

Key word search on 'durability'.- 1 citations found 0 from AS AS/NZS, 1 UNE standard related to corrosion

UNE EN ISO 22975-3:2015	Solar Energy - Collector Components and Materials - Part 3: Absorber Surface Durability (ISO 22975-3:2014)

Key word search on 'corrosion' or 'corrosivity' or 'corrosive'; but not 'anodizing' or 'anodize(d)'- 13 citations in all – 0 from AS/NZS	
ISO 15106-7:2015	Plastics - Film and sheeting - Determination of water vapour transmission rate - Part 7: Calcium corrosion method
ISO 17224:2015	Corrosion of metals and alloys - Test method for high temperature corrosion testing of metallic materials by application of a deposit of salt, ash, or other substances
ISO 17245:2015	Corrosion of metals and alloys - Test method for high temperature corrosion testing of metallic materials by immersing in molten salt or other liquids under static conditions
ISO 17248:2015	Corrosion of metals and alloys - Test method for high temperature corrosion testing of metallic materials by embedding in salt, ash, or other solids
ISO 17945:2015	Petroleum, petrochemical and natural gas industries - Metallic materials resistant to sulfide stress cracking in corrosive petroleum refining environments
ISO/FDIS 15156-3	Petroleum and natural gas industries - Materials for use in H_2S-containing environments in oil and gas production - Part 3: Cracking-resistant CRAs (corrosion-resistant alloys) and other alloys
ISO/FDIS 16540	Corrosion of metals and alloys - Methodology for determining the resistance of metals to stress corrosion cracking using the four-point bend method
DR AS 2809.4:2015	Road tank vehicles for dangerous goods - Tankers for toxic and corrosive
DIN EN ISO 15156-3 (2015-06) (Draft)	Petroleum and natural gas industries - Materials for use in H_2S-containing environments in oil and gas production - Part 3: Cracking-resistant CRAs (corrosion-resistant alloys) and other alloys (ISO/FDIS 15156-3:2014); German and English version FprEN ISO 15156-3:2015
DIN EN ISO 7441 (2015-04)	Corrosion of metals and alloys - Determination of bimetallic corrosion in atmospheric exposure corrosion tests (ISO 7441:2015)
UNE EN 10088-2:2015	Stainless Steels - Part 2: Technical Delivery Conditions for Sheet/Plate and Strip of Corrosion Resisting Steels for General Purposes
UNE EN 10088-3: 2015	Stainless Steels - Part 3: Technical Delivery Conditions for Semi-Finished Products, Bars, Rods, Wire, Sections and Bright Products of Corrosion Resisting Steels for General Purposes
MIL HDBK 1250 Revision A Notice 3 Validation	Corrosion Prevention And Deterioration Control In Electronic Components and Assemblies - Revision a Notice 3 Validation
Key word search on 'paint' and or 'coating'; but not 'anodizing' or 'anodize(d)' or corrosion– 19 Publications found; 0 from AS AS/NZS;	
ISO/DIS 13073-3	Ships and marine technology - Risk assessment on anti-fouling systems on ships - Part 3: Human health risk assessment of biocidally active substances in anti-fouling paints on ships during the application and removal process
ISO/DIS 19399	Paints and varnishes - Wedge-cut method for determination of film thickness (scribe and drill method)
DIN EN ISO 8502-9 (2015-04) (Draft)	Preparation of steel substrates before application of paints and related products - Tests for the assessment of surface cleanliness - Part 9: Field method for the conductometric determination of water-soluble salts (ISO/DIS 8502-9:2015); German and English version prEN ISO 8502-9:2015
FORD WSS M4G446 A1:2015	Engineering Material Specification - Nvh, Waterbased Acrylic, Sprayable, Primer & Paint Oven Heat Curing
BS X38:2005+A1:2015	Heat Curing Paint Scheme for Aerospace Purposes - Specification
ISO/DIS 10110-9	Optics and photonics - Preparation of drawings for optical elements and systems - Part 9: Surface treatment and coating
ISO/DIS 19477	Metallic and other inorganic coatings - Measurement of Young's modulus of thermal barrier coatings by beam bending
ISO/DIS 2286-2	Rubber- or plastics-coated fabrics - Determination of roll characteristics - Part 2: Methods for determination of total mass per unit area, mass per unit area of coating and mass per unit area of substrate
ISO/FDIS 7623	Steel cord conveyor belts - Cord-to-coating bond test - Initial test and after thermal treatment
JIS G 3443-3:2014	Coated steel pipes for water service - Part 3: Long-life external plastic coatings
JIS G 3443-4:2014	Coated steel pipes for water service - Part 4: Internal epoxy
JIS G 5528:2014	Epoxy-powder coating for interior of ductile iron pipes and fittings coatings
DIN EN ISO 12736 (2015-04)	Petroleum and natural gas industries - Wet thermal insulation coatings for pipelines, flow lines, equipment and subsea structures (ISO 12736:2014); English version EN ISO 12736:2014

DIN EN ISO 14577-4 (2015-05) (Draft)	Metallic materials - Instrumented indentation test for hardness and materials parameters - Part 4: Test method for metallic and non-metallic coatings (ISO/DIS 14577-4:2015); German and English version prEN ISO 14577-4:2015
DIN EN 16602-70-13 (2015-05)	Space product assurance - Measurements of the peel and pull-off strength of coatings and finishes using pressure-sensitive tapes; English version EN 16602-70-13:2015
MIL C 21067 Revision C Notice 2 Validation	Coating Compound, Synthetic Rubber, for Exposed Steel Surfaces - Revision C Notice 2 Validation
15/30295520 DC BS EN ISO 2286-2	Metallic and Other Inorganic Coatings - Measurement of Young's Modulus of Thermal Barrier Coatings by Beam Bending
15/30300655 DC BS ISO 19477	Rubber- or Plastics-Coated Fabrics - Determination of Roll Characteristics - Part 2: Methods for Determination of Total Mass per Unit Area, Mass per Unit Area of Coating and Mass Per Unit Area of Substrate
BS 2X 35:2003+A1:2015	Selectively Removable Intermediate Coating for Aerospace Purposes
Key word search on 'galvanize' or 'galvanized' or galvanizing' – 0 Standard Publications found;	
Key word search on 'corrosion' and 'concrete' or 'concrete' and 'coatings' - 0 Standard Publications found	
Key word search on 'cathode' or 'cathodic' -1 corrosion related Standard Publications found; 0 AS AS/NZS Publications	
BS ISO 15589-1:2015	Petroleum, Petrochemical and Natural Gas Industries - Cathodic Protection of Pipeline Systems - Part 1: On-Land Pipelines
Key word search on 'anode' or 'anodes' or 'anodic' – 0 corrosion related standards found	
Keyword Search on 'electrochemical' or 'electrolysis' or 'electroplated' - 0 Standard Publications	
Keyword Search on 'anodize' or 'anodized' - 0 Corrosion related publications found	

Arthur Austin
ACA Standards Officer

Hychem International Pty Ltd

Q: In what year was your company established?

A: In 1987, Hychem was formed by Wolfgang Bauer to satisfy the demand for an Australian based company servicing the construction industry with epoxy resin technology.

Q: How many employees did you employ when you first started the business?

A: One !

Q: How many do you currently employ?

A: 15 dedicated members at present, making up our of our sales, operational, laboratory, manufacturing and admin teams.

Q: Do you operate from a number of locations in Australia?

A: Yes, Offices in Sydney, Melbourne, Brisbane and technical sales reps serving, Tasmania, WA, SA and NT.

Q: What is your core business? (e.g. blasting and painting, rubber lining, waterjetting, laminating, insulation, flooring etc.)

A: Hychem are Australian formulators and manufacturers of polymer systems suited to the construction industry. Technology includes epoxy resin, polyurethane, Poly cements, methacrylate and epoxy grouts.

Our technical team continues to develop new products for the market. Hychem provide technical support, advisory and specifications to a range of clients.

Q: What markets do you cover with your products or services? eg: oil & gas, marine, chemical process, general fabrication, tank lining, offshore etc.

A: Our product range is so versatile it virtually covers every market within commercial, industrial and residential construction. Flooring options, grout for machinery, waterproofing technology, concrete rehabilitation for water industry, marine products.

Typical flooring markets include, food and beverage manufacturing, mining, supermarkets, car parks, motor workshops, retail, warehouses, prisons, hospitals, commercial kitchens…the list goes on!

Q: Is the business yard based, site based or both?

A: Our manufacturing, technical and admin staff operate out of or head office in Sydney. Our technical sales team visit and support projects in all major capital cities and remote areas. From the Pilbara to Far North Queensland Hychem physically support a wide geographical area.

Q: Do you offer any specialty services outside your core business? (eg. primary yard based but will do site touch up etc.)

A: Tailor-made technical solutions. Working closely with clients to formulate and test unique products for a particular scenario.

Q: What is the most satisfying project that you have completed in the past two years and why?

A: There have been numerous over the years, a recent standout was one from Queensland. QLD university St Lucia, 6500 square metres of 4mm Hychem WE500. The product WE500 was a new green star rated high build epoxy with excellent and unique properties. This was the first ever project of this size and complexity. The product was chosen for the technical aspects of the product, Hychem assisted in a great deal of research with the government to get the product approved.

Q: What positive advice can you pass on to the Coatings Group from that satisfying project or job?

A: Work closely with the client, understand their needs, explore all the technical aspects, become the expert in the design.

Q: Do you have an internal training scheme or do you outsource training for your employees?

A: Due to the type of technical training required, where necessary we will outsource our training.

Contact: Head Office
Unit 1, 30 Bluett Drive
SMEATON GRANGE,
NSW, 2567
T: (02) 4646 1660
M: 0410 319 557
colin@hychem.com.au
www.hychem.com.au

HYCHEM
EPOXY SYSTEMS

Corrosion Management Experiences in the Water & Wastewater Industry

26 March 2015 • Melbourne

The Water & Water Treatment Technical Group of the ACA held a technical event on Thursday 26 March at the Marriott Hotel in Melbourne.

This full day technical event had over 100 delegates from a broad cross section of the industry in attendance. This event covered and investigated ways of protecting and maintaining our water assets from corrosion. With a range of speakers from a who had a real depth of experience and good presentation styles this day was thoroughly enjoyed by all that attended.

At the conclusion of the event an open floor forum was held and chaired by Dean Ferguson, which provided much discussion on the issues within the industry.

The ACA would like to thank all speakers, sponsors and delegates who attended this event and for making the day a huge success!

Below is an overview and summary of the presentations provided by the speakers:

Current State of Play for the Australian Water Industry

Greg Ryan, Water Services Association of Australia

This presentation looked at the key drivers for the water industry nationally, as well as the recent developments affecting the industry including:

- Critical aspects of asset management including understanding risk, analytical methods and asset condition assessment tools.
- Cathodic protection
- How codes and appraisals can help avoid installation issues.
- Lessons in odour and corrosion for sewer networks, key outcomes and next steps regarding the Sewer Corrosion and Odour Reduction (SCORe) project

Using Failure Data to Provide Insights to Water Main Condition and Corrosion Mechanisms

Phil Hart, Melbourne Water

This presentation outlined that failure plots for water mains that show failures vs. change and time have helped Melbourne Water better understand water main condition and corrosion mechanisms. There is significant variability between mild steel mains and a strong trend of external corrosion failures continuing in the same location.

Corrosion and Materials Selection at Wastewater Treatment Plants

Sarah Furman, AECOM

This presentation discussed the why and how wastewater is treated. Information was presented on the variety of exposure environments within a treatment plant and what forms of materials degradation can occur within these environments. Data was presented on the resistance of metals and concrete to these environments and examples were given of good and poor materials selection.

Underside Corrosion in Steel Storage Tanks in the Water Industry

Jamie O'Brien, International Paint

This presentation looked at a specific case study involving the tank assets of Melbourne Water, where they were faced with wide spread underfloor tank bottom corrosion. The presentation looked at the solution identification process, the selection criteria used and the ultimate installation of the selected system. An overview was given on the relevant merits of different tank floor remediation options, and the costs benefits achievable from novel solutions.

Advanced Materials in Desalination Plants

David Parravicini, Degremont

Commissioned in November 2006 the Perth Seawater Desalination Plant was the first large scale desalination plant in Australia. Operated by Degremont Australia in an alliance partnership with the Water Corporation the plant represents 17% of Perth's drinking water supply and has been a vital climate independent water source for the community. PSDP has been heralded as a leader in industry with the plant being named Desalination Plant of the year (Water Desalination Report, 26 November 2012), has contributed over 300 gigalitres of potable water to the Perth community and has set a high standard in production and safety. (Averages 99.7% Availability, Over 3000 LTI Free Days).

Desalination plants often operate in harsh conditions with a majority of large scale plants operating in coastal environments. This coupled with the large amounts of seawater and brine processed by these facilities, mean a high standard of materials are chosen to give optimum life. Materials range from composites such as HDPE and GRP piping, concrete, high alloy steels and even titanium. However advanced materials are, attention must still be given to ensure the materials meet their expected life. This presentation aimed to give insight into some of the corrosion mechanisms specific to seawater desalination, failures encountered and some of the strategies used to prolong asset life.

Corrosion Mechanisms in Sewers and Rehabilitation Options

Dr Chris Weale, GHD

The corrosive nature in wastewater assets varies considerably, depending largely on the properties of the construction materials and exposed micro/macro environment condition. This presentation discussed corrosion mechanism in sewer environments, including some recent findings of the SCORe research project. Sewer pipe rehabilitation options including crown spraying, protective coatings and liners, and re-lining were also discussed.

Field Testing Methods and Condition Monitoring Technology for Concrete in Water Infrastructure

William Ward, PCTE

Water infrastructure may be exposed to corrosion issues common to Australian coastal environments and also to unique corrosion behaviour specific to fresh water infrastructure and wastewater treatment. This presentation discussed and presented short case studies on tools used for both the investigation of structures for evidence of corrosion or corrosion risk and for long term automated monitoring of infrastructure. The focus was mainly on Concrete and related materials matching PCTE's expertise.

As hidden steel encased in concrete cannot be directly inspected, electrochemical techniques can be used both for risk assessment and monitoring. Some wastewater environments are also at risk of degradation of the concrete itself. Through means such as acid sulphate attack, it is possible to assess the degree of this damage. Finally concrete degradation can directly influence the performance of water retaining structures, issues such as penetrating cracking, joints and caulking failure and defects at the time of construction can allow water to access assets at risk from corrosion.

Protecting Australia's Water Industries Assets

Michael Harrington, McElligotts

The Kangaroo Valley Pipe Project was a massive undertaking by McElligotts which presented many challenges. It required a 2.6 metre by 1.8 km underground pipeline to be relined with a solvent-less epoxy lining, the task made even more challenging with the issue of only being two access points across the full 1.8km of pipe. The initial work was to remove the old vinyl ester coating from the steel and then abrasive blast using a robotic blaster system, then re-line with a 0% waste policy through one of the access points. This presentation explored the challenges that were faced, and discussed how they were overcome effectively, to allow this project to be completed a month ahead of schedule.

Images from the workshop.

Protecting Infrastructure Against Corrosion

Durability Planning

14 May 2015 | Auckland

PROUDLY PRESENTED BY: Australasian Corrosion Association Inc.

SPONSORS: International; galvanizers Association of Australia; Galvanizing Association NZ

The New Zealand Branch of the ACA held a technical event on Thursday 14 May at the Crowne Plaza in Auckland.

This full day technical event & exhibition had over 60 delegates from a broad cross section of the industry in attendance. This event covered and investigated ways to better protect our vital assets by use of durability planning. With a range of speakers who had a remarkable depth of experience this day was thoroughly enjoyed by all that attended.

At the conclusion of the event a networking cocktail function was held in the exhibition hall, which contained products and services from 10 exhibitors.

The ACA would like to thank all speakers, sponsors, exhibitors and delegates who attended this event and for making the day a huge success!

Below is an overview and summary of the presentations provided by the speakers:

Durability and the NZ Building Code

Nick Marston, BRANZ

The New Zealand Building Code is primarily performance-based: only for a few classes of materials such as timber and concrete, do prescriptive ‘deemed-to-satisfy’ solutions exist. For other situations, the Code offers only the advice that suitable durability performance may be demonstrated through either laboratory testing, a documented history of use, or by analogy with the behavior of similar building components. Consequently the capability for robust durability assessment of new products and techniques is an essential platform for supporting an innovative, dynamic building industry.

Durability Planning and Detailing for Optimum Material Performance

Raed El Sarraf, Opus International Consultants

Corrosion affects all construction materials, whether it is concrete, steel or timber. At the commencement of any project, durability planning should be conducted to assist in the material selection, specification and development of a maintenance plan for the given structure. In addition to this, the appropriate detailing should be considered at the design stage, which will assist in minimising the risk of preventable durability issues occurring during the life of the structure. This approach to the problem, will not only assist in optimising the material performance, but also potentially reduce future maintenance costs. This presentation outlined the durability design philosophy, a discussion on the current guidance given in the durability provisions outlined in the NZ Building Code, and listed the available industry guidance. It concluded with a number of commonly seen detailing errors and their solutions.

Increasing the Longevity of Assets through Risk Based Inspection and Coating Solutions

Ross Mackenzie, International Paint

This overview presentation recognized that the efficient and effective use of physical assets is a key enabler that allows organizations to perform well: they can lower cost and risk, eliminate potential HSE dangers and elevate performance and share price when managed correctly. The implementation of a Risk based inspection system which quantifies and predicts corrosion rates assist's in identifying the 'window of opportunity' , a maintenance program that works with the owners schedules provides and puts the 'maintenance & facility manager' back in control.

Durability of Key Infrastructure – A Structural Engineer’s Perspective

Stewart Hobbs, Proconsult

Safe-guarding against the deterioration of structures can be a complex issue which is affected by many variable factors: geometry, how the loads are applied over the service life of the structure, limitations on cracking in concrete, material properties, assembly and method of construction and controlled and uncontrolled environmental conditions. Whilst there are codes of practice that set minimum design standards of practice for structural engineers for the loads applied to structures and minimum durability criteria, there are still many examples of poor design in new buildings and structures. Poor (substandard) designs are problematic in several ways including early failure, poor return on investment, reputational impacts and cost and time factors for reinstatement. Structural engineers are also called upon to investigate ways of extending the life of structures well beyond their original design life. Often this review calls for innovative and new perspectives on the original design in order to adapt a building or structure to suit later changes in use and/or management or to extend its useful life. This paper briefly addressed some key concerns with regard to examples of infrastructure design and related durability issues and describes the potential modes of failure and means of rectification. Arriving at the highest and best ongoing use of a structure can be a subjective topic often open to criticism, but invariably driven by the best return on investment.

The Yanks Are Coming – Waikaraka Park Grandstand 72 Years On

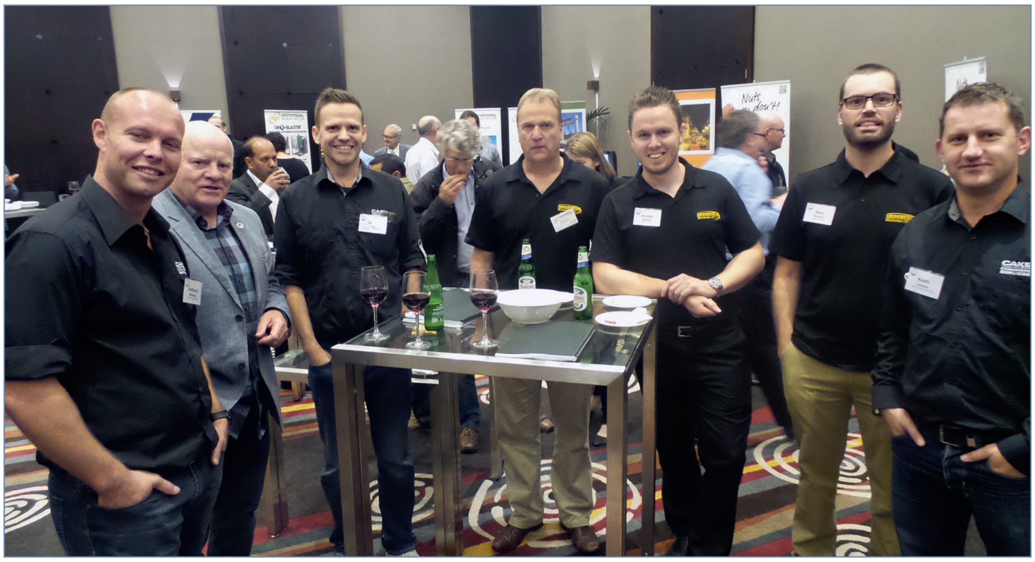
Paul Ivory, Auckland Council

Waikaraka Park is located on Neilson St Onehunga and is currently used for Speedway racing. The concrete grandstand on site was originally constructed circa 1942 when the United States army 'invaded' New Zealand. With the world at war and New Zealand troops in the North Africa and the Japanese threat in the Pacific looming, New Zealand requested that our troops be released from the North African campaign and returned home to defend our Islands. Churchill was fiercely against this as he was concerned that the Axis Forces would invade through Egypt and have access to the Middle East oil fields. With America now fully involved it was agreed that American troops would be stationed in New Zealand as both a training ground for troops going into the Pacific Islands in the campaign to regain those areas invaded and held by the Japanese and a recuperation centre for troops returning from combat. American troops were stationed at Whangarei, North Auckland Wairarapa, Kapiti and Wellington. At any one time between June 1942 - mid 1944 there were between 1,500 - 45,000 servicemen in camp in New Zealand. The Americans brought their sports with them and while stationed at Waikaraka Park, US servicemen engineers constructed a reinforced concrete grandstand. It is thought that the American's used sea sand in the aggregate mix (likely given the proximity to the sea). The subsequent heavy corrosion of the structure is thought to be a result of the sand's effect on the reinforcing steel. The first sign of corrosion of the structure was noted in 1983 by the then Onehunga Borough Council when the lower deck section of the stand was closed to the public due to falling concrete. Repairs were carried out at this time. The problems of falling concrete once again came to the fore in late 2014. The earlier repairs that were carried out in 1983 had deteriorated over the last 32 years when spalling concrete was once again a problem and sections of the lower grandstand were closed to the public. Many of the previous repairs are now failing and the previous patches may have masked problems. The loss of structural integrity is no longer to be regained by patching alone. This presentation discussed in detail the deterioration/corrosion of the reinforcing and future options available.

A Guide to AS/NZS2312.2 (2014) Hot Dip Galvanizing – What Is It & Why You Need To Tell Your Customers About It

Peter Golding, Galvanizing Association of New Zealand

Early in the review process of AS/NZS 2312:2002, Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings, it was recognised that steel designers would benefit by separating the Standard into product specific sections to avoid confusion. The revised Standard was released in December 2014; with Part 1 covering paint systems and Part 2 covering hot dip galvanizing (HDG). Both new parts to the Standard use the same definitions from AS 4312 for corrosivity categories in Australia, but now clearly recognise that the design process and durability of the two products are very different. Designers wishing to specify HDG need only use two Standards; one covering the design and durability of HDG steel (AS/NZS 2312.2), and the other dealing with the manufacturing process and tolerances (AS/NZS 4680). This presentation provides an introduction to the key features of the hot dip galvanizing component (Part 2) of AS/NZS 2312. The presentation showed how the new Standard will allow designers to more accurately estimate the durability of HDG coatings and illustrate good design practice. In addition, the presentation provided design advice for duplex coatings and explained the effect of the steel chemistry on the final coated product. The presentation also covered the new Standard to NZS 3404.1 and the NZTA Manual.



Durability Planning: Optimising Materials Selection - A Strategic Asset Management Approach

Brian Sharman, AECOM

Obtaining asset condition data that can be used by asset managers to forecast maintenance and renewal costs is difficult to do as you need to be able to build in deterioration models to predict future condition, intervention times and costs for those interventions as well as a risk/criticality component, so that money is not spent unnecessarily on defects that do not affect the service performance of the asset. This presentation provided an overview of how a good understanding of materials and how they will perform can be used to build effective prioritization and cost forecasting tools that turn data into good decision making information.

Concrete Durability – A Practical Guide to Managing the Risks for NZ Infrastructure

Sue Freitag, Opus International Consultants

When documented in detail, the number and complexity of processes involved in durability planning for concrete structures appears daunting. This suggests durability planning is only practical for high value projects. Many aspects, however, are already incorporated within current practices for design, materials, construction, and maintenance. Others are straightforward, but perhaps yet to be used to best advantage. This presentation discussed durability planning as it applies to NZ concrete infrastructure. It described key aspects by relating them to NZ concrete materials technology and industry practice, and illustrating them with local examples. By demystifying the process it helped specifiers, asset owners, and asset managers manage the durability of New Zealand concrete infrastructure so that structures meet the service life requirements of their owners.

Ilico Apartments Case Study – Designing for Durability and Aesthetics Using a Duplex Coating System

Duane Baguley, Perry Metal Protection

The Ilico apartment consists of 65 one and two bedroom apartments over five levels in the newly established suburb of Stonefields in Auckland. All of the apartments have either a north facing courtyard or balcony, while a south facing boardwalk at each level provides bridge access to each apartment. This case study discussed the process of coating selection for the exterior steel structures which involved the builder, architect and coatings specialists working together to arrive at the right solution. A duplex coating system was selected for the steel structures in order to meet the durability, aesthetic and long term maintenance requirements of the structure and the advantages of using this system was explored. A number of the key learnings that require consideration for future projects were discussed.

EXHIBITORS

The ACA would like to thank all the exhibitors at the event:

BLASTQUIP – Providing Surface Preparation & Coating Solutions
carboline – Coatings · Linings · Fireproofing
FREYSSINET
GALVANIZING ASSOCIATION NZ
HEMPEL
INDUSTRIAL Minerals (NZ) Ltd
International
JOTUN
MSS – METAL SPRAY SUPPLIERS (NZ) LTD
NZ CORROSION SERVICES – Protective Coating Consultants & Certified Inspectors

Concrete Assets – Experiences with Repair & Maintenance

Proudly presented by: Australasian Corrosion Association Inc.

Perth
25 June 2015

Overview

The Concrete Structures & Buildings Technical Group of the ACA has produced a technical program that will investigate and discuss the repairing and maintenance of concrete assets across a range of industry sectors. This event will continue to build on the success from previous concrete themed events.

This event will focus on real life case studies, exploring both successes and failures. The presenters will share their experience and the lessons they have learnt.

To ensure this event is a success and to bring the industry together, we will have industry experts from each of the following industry groups presenting various real life case studies;

✦ Asset Owners ✦ Consultants ✦ Contractors ✦ Suppliers

This one day event will help bring together all stakeholders to discuss and learn about various corrosion issues across the concrete structures and buildings fields. To end the day we will engage the audience to participate in an open forum to discuss concrete related corrosion issues with the panel of speakers.

Venue

Mercure Perth
10 Irwin Street
Perth WA 6000

Contact

For further information on this event please contact Brendan Pejkovic on +61 3 9890 4833 or bpejkovic@corrosion.com.au

Program

Time	Session	Speaker
8.30 – 8.55	**Registration**	
8:55 – 9:00	**Welcome and Seminar Opening**	Mohammad Ali, ACA President
9.00 – 9.40	Concrete & Durability Planning	Rodney Paull, GHD
9.40 – 10.20	Testing for Corrosion in Concrete - A Practical look at the Pitfalls of Interpreting Data	Reuben Barnes, PCTE
10.20 – 10.50	**Morning Tea**	
10.50 – 11.30	Project Case Studies in Concrete Remediation	Deane Diprose, Duratec
11.30 – 12.10	Crystalline Technology: A Solution to Repair and Rehabilitation of Concrete Structures	Farhad Nabavi, Xypex
12.10 – 13.00	**Lunch**	
13.00 – 13.40	Service Life Extension for Concrete Transport Infrastructure in Coastal Environments	Rob Kilgour, AECOM
13.40 – 14.20	Evolution of Repair Solutions for Concrete Structures	Grant Dowling, Sika Australia
14.20 – 14.50	**Afternoon Tea**	
14.50 – 15.30	Remedial Technologies – Long Term Enhancement for Concrete Structures	Mike Rutherford, Freyssinet
15.30 – 16.10	The Repair and Maintenance Heritage Listed Concrete Assets	Liam Holloway, Mend Consulting
16.10 – 16.55	Open Floor Speakers Forum and Discussion	
16.55 – 17.00	**Seminar Close**	Mohammad Ali, ACA President
17.00 – 18.30	**Cocktail Function**	

Register Now at www.corrosion.com.au

Corrosion Research at UQ

The University of Queensland
AUSTRALIA

Prof Andrej Atrens leads the corrosion effort at The University of Queensland (UQ). He has a B.Sc. (Hons) and a PhD from the University of Adelaide, and a DEng from UQ. Research includes (i) corrosion, biocorrosion, and stress corrosion cracking of light alloys with a focus on Mg, and (ii) hydrogen influence on medium strength steels. Ten (10) significant publications are given below [1-10].

Current and Recent Research Projects

1. Corrosion and stress corrosion cracking of light alloys with a particular focus on Mg.

A/Prof Matt Dargusch, Dr Zhiming Shi, Post-Doctoral Fellow, Fuyong Cao, graduating PhD student, Funded by ARC Centre of Excellence Design in Light Alloys, Defence Materials Technology Centre, GM Global Research & Development.

Justification. Corrosion is one of the main limitations for the more widespread use of Mg alloys. A better understanding of the factors influencing corrosion behaviour is expected to lead to the next generation of Mg alloys with corrosion properties significantly better than existing alloys.

Achievements. We have shown in principle that ultra-high-purity Mg alloys will have corrosion properties as good as the best currently available (ultra-high-purity Mg) and may have significantly lower corrosion rates.

2. Hydrogen influence on metallic components for clean energy.

Qian Liu PhD recently awarded, Funded by an ARC Linkage with Alstom Switzerland.

Justification. It is cost effective to use conventional medium-strength-steels for vessels and piping for the hydrogen economy.

Status. Provided a deeper understanding of the influence of hydrogen on four medium-strength quenched-and-tempered steels.

3. Influence of hydrogen on steels for auto contruction.

Jeffery Venezuela and Qinglong Liu, PhD students, Funded by Baosteel-Australia Joint Research and Development Centre.

Justification. The use of advanced high strength steels enables the building of lighter, more-fuel-efficient cars. These steels have strengths such that there is a possibility of hydrogen influences.

Status. This project is carrying out a fundamental evaluation of the influence of hydrogen of these steels.

4. Biodegradation of Mg.

Sean Johnston, PhD student, Funded by UQ APA scholarship.

Justification. Biodegradation of a medical implant after the body has healed obviates the operation that is needed to remove e.g. a Ti bone plate.

Achievements. This project has just commenced.

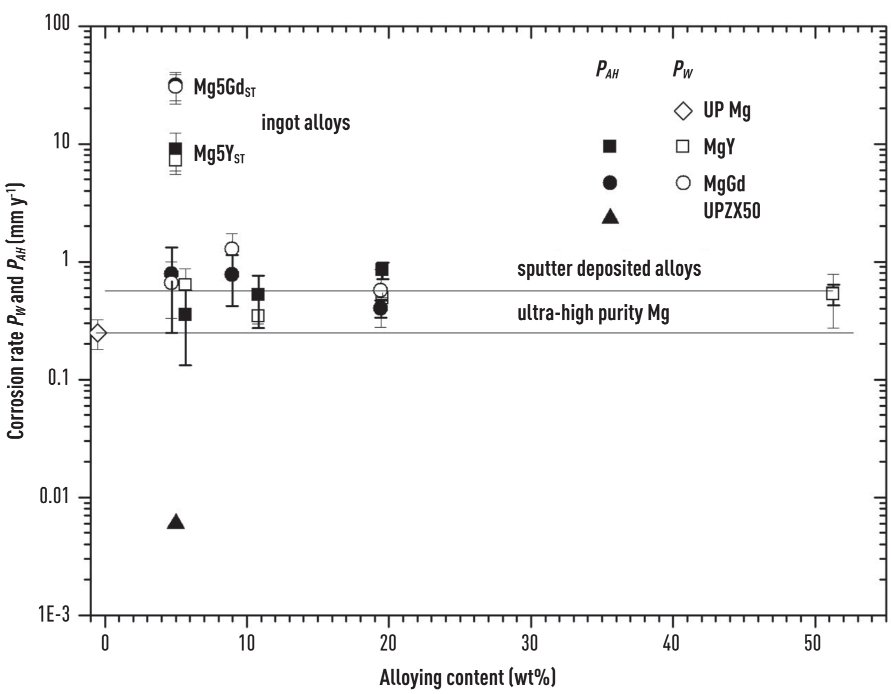


Figure 1. Low corrosion rates might be possible if it is possible to find a Mg-X alloy, which forms a protective surface oxide based on X rather than based on Mg as usually occurs for Mg alloys. This is analogous to an oxide based on Cr forming on stainless steels provided the Cr content is greater than 11%. That this might be possible is shown by the corrosion rates of the sputter-deposited alloys {MgY (squares) and MgGd (circles)}, which were comparable with those of ultra-high-purity (UP) Mg (diamond) and much lower than those of the ingot-metallurgy solution-heat-treated alloys {$Mg5Gd_{ST}$ (circles) and $Mg5Y_{ST}$ (squares)}. All the alloying elements were dissolved in the Mg matrix for the sputter deposited alloys, whereas the ingot alloys contained second phases which accelerate the corrosion rate by micro-galvanic coupling. The intrinsic corrosion rate for ultra-high-purity Mg is P_W = 0.27 ± 0.07 mm y^{-1}. Corrosion rates in 3.5 % NaCl solution saturated with $Mg(OH)_2$, were evaluated from average hydrogen evolution rate, P_{AH} (closed symbols), and weight loss, P_W (open symbols). The corrosion rate of the ultra-pure alloy ZX50 is also plotted. For more information please see references [1,4].

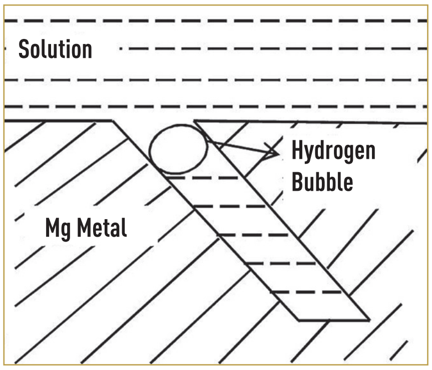


Figure 2. An idealisation showing how corrosion inside a crevice can be isolated from the solution by the evolving hydrogen, so that such corrosion cannot be measured by any electrochemical measurement. For more information please see reference [1].

The University of Queensland.

Figure 3. Mt Aso, Japan. Smoking is bad for your health.

References

1. A. Atrens, G.-L. Song, M. Liu, Z. Shi, F. Cao, M.S. Dargusch, Review of recent developments in the field of magnesium corrosion, Advanced Engineering Materials, 17 (2015) 400-453.

2. A.D. Atrens, I. Gentle, A. Atrens, Possible dissolution pathways participating in the Mg corrosion reaction, Corrosion Science, 92 (2015) 173-181.

3. Q Liu, AD Atrens, Z Shi, K Verbeken, A Atrens, Determination of the hydrogen fugacity during electrolytic charging of steel, Corrosion Science, 87 (2014) 239-258.

4. K Schlüter, Z Shi, C Zamponi, F Cao, E Quandt, A Atrens, Corrosion performance and mechanical properties of sputter-deposited MgY and MgGd alloys, Corrosion Science 78 (2014) 43-54.

5. NI Zainal Abidin, B Rolfe, H Owen, J Malisano, D Martin, J Hofstetter, PJ Uggowitzer, A Atrens, The in vivo and in vitro corrosion of high-purity magnesium and magnesium alloys WZ21 and AZ91, Corrosion Science 75 (2013) 354-366.

6. Q Liu, B Irwanto, A Atrens, The influence of hydrogen on 3.5NiCrMoV steel studied using the linearly increasing stress test, Corrosion Science, 67 (2013) 193-203.

7. A Prasad, P.J. Uggowitzer, Z. Shi, A Atrens, Production of high purity magnesium alloys by melt purification with Zr, Advanced Engineering Materials, 14 (2012) 477-490.

8. A Prasad, Z Shi, A Atrens, Influence of Al and Y on the ignition and flammability of Mg alloys, Corrosion Science, 54 (2012) 153-163

9. A Atrens, M Liu, NI Zainal Abidin, Corrosion mechanism applicable to biodegradable magnesium implants, Materials Science and Engineering B, 176 (2011) 1609-1636.

10. Z Shi, A Atrens, An innovative specimen configuration for the study of Mg Corrosion, Corrosion Science, 53 (2011) 226-246.

Peer-reviewed research publications since 2010

61 journal publications
7 book chapters

Contact Details

Professor Andrej Atrens
Division of Materials Engineering
The University of Queensland, Brisbane, Qld Australia 4072

CRICOS Provider Number: 00025B
T: (07) 3365 3748;
International Tel: +61 7 3365 3748
Andrejs.Atrens@uq.edu.au

ACAF International Travel Scholarship Report

by Mike Rutherford
Part 2

The first section of my ACA Foundation International Travel Scholarship Report covered the Inaugural NACE European Corrosion Conference-Expo 2014 in Spain and the Corrosion Prevention and the Protection System developed for the Chernobyl Sarcophagus Confinement Shelter Project in Ukraine.

This report covers site visits to projects of significance and meetings with key personnel to discuss challenging concrete cathodic protection projects and market trends.

France:– Challenging Concrete CP Projects

Following attendance at the Inaugural NACE European Corrosion Conference-Expo 2014 in Spain I travelled to France where site visits and project meetings were held to discuss and overview challenging concrete cathodic protection project works and market trends in cathodic protection.

Issy les Moulineaux Swimming Pool

Issy-les-Moulineaux is situated in the southwestern suburban area of Paris. The area has successfully moved its economy from an old manufacturing base to high value-added service sectors and is at the heart of the Val de Seine business district which is the largest cluster of telecommunication and media businesses in France hosting the headquarters of most major French TV networks.

The structure was built in 1972 and the roof is composed of independent prefabricated prestressed concrete shells.

Prefabricated Prestressed Concrete Shell Roof Construction.

Following delamination of some concrete and subsequent condition assessment with diagnostic testing it was determined that corrosion was evident in some of the prestressed wires.

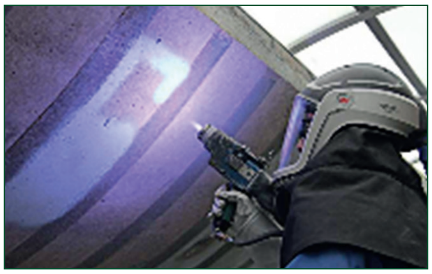
Detailed design was undertaken for access scaffolding, concrete surface preparation by ultra-high pressure water jetting, concrete patch repairs, carbon fibre strengthening and additional prestressing cable, zinc sprayed galvanic protection and refurbishment of the waterproofing.

Scaffolding access was erected to provide adequate access to allow working on all of the beams simultaneously from the internal and external structure and provide for the collection of waters from surface preparation water jetting.

Internal Access Scaffolding.

Concrete Patch Repair.

Carbon Fibre Strengthening.



Zinc Spray Galvanic Protection.

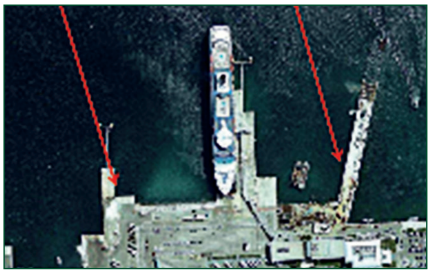
Applied Waterproof Membrane.

The duration of works for this project was seven months.

Ajaccio Harbour Deck - Corsica Island

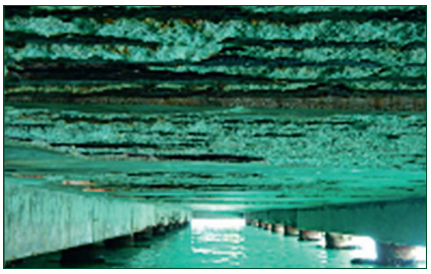
Ajaccio is the largest settlement on the island of Corsica in the Mediterranean Sea located west of Italy and south-east of the French mainland, and north of the Italian island of Sardinia.

The cathodic protection component of the Ajaccio Harbour Deck Concrete Repair and Cathodic Protection Project comprises the installation of 3,500 discrete anodes and 3,500m² of titanium mesh anode.



Site Area for Deck Repair

The scope of works for this project was to undertake detailed design for access from submerged platforms, removal of polluted concrete, reinforcement replacement (170 tonnes), concrete repair by shotcrete application (2,000 tonnes) and cathodic protection through discrete anode and mesh anode systems with multi-zone monitoring.



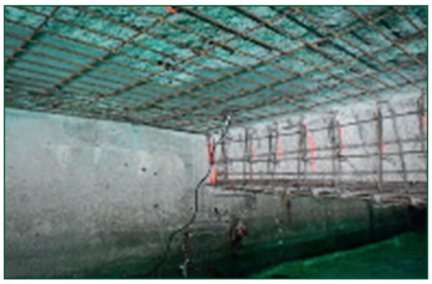
Condition of Deck Prior to Commencement.

Access to the work areas was difficult and achieved through a combination of submerged platforms and rope access.

The duration of works for this project is scheduled for 2 years.

Submerged Platform Access.

Concrete Removal and Rebar Replacement.



Anode Placement.

Conductor Installation.

Viaduc de Sylans – Lake Sylans

The A40 is a motorway in France that extends from Mâcon on the west to Saint-Gervais-les-Bains on the east, terminating not far from Chamonix and the Mont Blanc Tunnel. The road runs 208 kilometres through Bresse, the high southern Jura Mountains, northern Prealps and French Alps. It was fully completed in 1990, and includes 12 viaducts and 3 tunnels.

Sylans North and South Viaducts.

The poor design of drains and water harvesting seals and the lack of maintenance over time have provided a path for water loaded with road deicing salt to come into contact with and degraded reinforcement embedded within the concrete piers and footings of these structures causing heavy damage to the reinforced concrete.

Corroded and Degraded Reinforcement.

The installation of a cathodic protection system on the North and South Viaducts was implemented in November 2009 following detailed assessment of the structures. The findings of the detailed assessment recommended that the remediation works be undertaken immediately to avoid the prospect of an emergency being created.

The concrete cathodic protection component of the Viaduc de Sylans Project comprised the placement of titanium anodes, expanded titanium mesh and strip expanded titanium ribbon.

The geographical location of the structure presented challenges with harsh winters yielding snow and freezing temperatures. The scaffold was fully sheeted and heated to undertake the remedial works during cold periods.

Sheeted and Heated Scaffold.

The works undertaken included the hydro demolition (600m^2) of the main siding, the provision of an interim stability study, reinforcement replacement, dry shotcrete repair, installation of drilled titanium anodes, expanded titanium mesh and strip expanded titanium ribbon anodes.

Hydro Demolition and Rebar Replacement.

Following the completion of the hydro demolition stage of the works a study for structural stability was undertaken prior to the replacement of missing or badly corroded reinforcement.

Electrical continuity of reinforcement was checked prior to the placement and installation of anodes and reference electrodes and associated electrical wiring.

Anode & Reference Electrode Installation.

Siding reconstruction was completed by dry shotcrete process over an area of 600 m^2.

The titanium ribbon and anodes were then installed to the structure prior to the trowel finished application of the finishing mortar to an area of 600m^2.

Titanium Ribbon & Anode System Placement.

Trowel Finishing of Shotcrete.

Completed Remediation.

Challenging Conditions during Project Works.

The duration of the project works was for a period of 5 months.

Lavirot Bridge

The Lavirot Bridge is a beam girder bridge constructed in 1976 over the Cayenne River in French Guiana and consists of 35 spans of 35m over a total length 1.23km.

The Cayenne River is a 50km long river formed by the Cascades River and the Tonnégrande River and flows into the Atlantic Ocean near the city of Cayenne, forming a large estuary approximately 2km in length.

Lavirot Bridge.

When high tide level is reached the beams of the structure are immersed in the water. With these access restrictions prevalent, the available working times changed and working platforms required adjustment on a daily basis. Access was achieved using two mobile working platforms, three walkways and 290m² of floating platforms.

The cathodic protection component of the Lavirot Bridge Concrete Cathodic Protection Project comprised the placement of galvanic anodes (6,000) and protective coating application (4,500m²).

The location of post-tensioning tendons was mapped and marked prior to the drilling of galvanic anode holes and chasing of grooves to locate the connecting titanium wires.

Tidal Constraints.
Working times change every day. Access platforms must be adjusted every day. Some days can not be worked, Saturdays are worked.

Mobile working platforms.

Aluminium walkways.

Tidal Constraints and Working Platforms.

Floating platforms.

Tidal Constraints and Working Platforms.

Post Tensioning Locations Marked.

Following the installation of galvanic anodes and titanium wires the areas remediated had a concrete protective coating system applied.

Municipal Water Sports Center, La Grande-Motte

La Grande-Motte is a commune in the Hérault region in Languedoc-Roussillon in southern France. It is a popular seaside resort and port constructed in the 1960's and 1970's.

With 2 million tourists per year it is one of the favorite resorts of the French.

The Municipal Water Sports Centre building was constructed on the waterfront and covers an area of approximately 1000m². The initial construction was undertaken in 1983 with a workshop and storage area extension added in 1993.

The scope of works for the project was to remove the existing substrate coating, remove and reinstate concrete canopies, remediate degraded concrete, install a galvanic cathodic protection system and apply a concrete protective coating system.

An alternative proposal for the electrochemical protection scope of work was proposed with the process for the galvanic protection of reinforced concrete by coating thermally sprayed zinc accepted. Advantages of this process were more uniform and continuous protection of the surface, less structural trauma and surface treatment, greater weight of zinc protection per square metre in relation to hybrid anode systems (2 kg/m² zinc against 720g/m² for the hybrid system), providing structural continuity of the work, respecting the aesthetics of the building and reliability for total recovery of areas to be treated.

The existing external structure concrete's coating was removed by high pressure water jetting to provide a clean open surface substrate free from contamination. Areas of defective concrete were removed and remediated with a polymer-modified high build repair mortar prior to the application of the thermally sprayed zinc system.

Surface Preparation by HP Water Jetting.

Defective Concrete Removed & Remediated.

The selected galvanic protection system consists of a plasma torch applied layer of zinc to the concrete which is linked at intervals to the reinforcement by a system of stainless steel plates and rods in order to act as an anode. A pore-blocking coating is applied after the metal spraying operation, making it possible to apply a coloured finishing coat. This system is designed for use on structures built on the seafront in particular and is capable of providing protection for over 30 years. It is especially suitable for concrete structures for which the corrosion currents are moderate and can also be applied to new works as corrosion preventive protection.

Checking the thickness of the applied zinc layer was undertaken using a dry film thickness gauge with nominal thickness of 315 microns recorded.

Thermal Spray Applied Zinc CP System.

The cathodic protection works on the Municipal Water Sports Center at La Grande-Motte were undertaken between January and March 2010.

The system has been inspected and tested regularly since installation and is performing to the required standard.

England – Challenging Concrete CP Projects

Ketley and Dawley Bridges, M54, Telford

Telford is a large town in the borough of Telford and Wrekin and county of Shropshire, England, about 13 miles east of Shrewsbury, and 30 miles west of Birmingham. Telford is the largest town in Shropshire, and one of the fastest-growing areas in the United Kingdom.

The Ketley and Dawley Bridges refurbishment scheme on the M54 was undertaken between July 2013 and March 2014.

The works consisted of phased reinforced concrete repairs to abutments and piers, the replacement of Ketley East and Ketley West central pier bearing shelves and bearings utilising temporary jacks and support frames, the propping of decks from temporary support steelwork supported off the central piers, the installation and stressing of post tensioning to retain the steelwork system and transfer the jacking loads into the structure, and the hydro-demolition of 16m^3 of concrete from each of the central piers.

Temporary Support & Jacking Placement.

Several processes were undertaken on 24 hour working roster to maintain the client's programme such as the design, supply and erection of the access scaffolding, the design, supply and installation of new elastomeric bearings in accordance with client design requirements, the design, supply and installation of a cathodic protection system and the application of sprayed concrete overlay to the treated areas. The design of the cathodic protection system included the installation of a mesh and overlay impressed current system.

Mesh Overlay CP System.

The design of the access scaffolds for the works included the co-ordination of process to ensure that the access scaffold was sufficiently designed and checked to avoid impact on the travelling public with liaison with the traffic management provider to ensure full instigation of procedures.

Hydro-demolition was used for the removal of existing concrete and through liaison with the Environment Agency the project was able to utilise a cost effective method of treatment of hydro-demolition water in order to remove suspended solids and neutralise the water prior to discharge into the highway drainage network.

Reinforcement weld procedure trials were undertaken prior to the commencement of the works in accordance with the chemical analysis/carbon equivalent valuel of the reinforcement.

Sprayed concrete was used for the repair process as this proved to be less labour intensive than flowable repairs and curing periods for the material used were beneficial to the programme as the necessary requirement for 29 MPa was achieved in 2-3 days allowing the next stage of repair to commence. Previously completed extensive spray concrete trials demonstrated that the method of working achieved fully compliant repair by fully encapsulating the reinforcement with no de-bonding from the parent substrate.

In addition to these remediation procedures, the refurbishment of the decks of 3 bridges included the treatment and diversion of existing services, the removal of the existing carriageway surfacing, kerbing and resurfacing, and waterproofing in accordance with the Specification for Highway Works.

It also included the construction of a new slab over the service bays stitched into the existing deck, the treatment and removal of unforeseen asbestos by a specialist contractor, and the replacement of buried and mechanical deck joints.

South Hook LNG Jetty, Milford Haven, Cardiff

Milford Haven is a township community in Pembrokeshire, Wales. It is situated on the north side of the Milford Haven Waterway, an estuary forming a natural harbour that has been used as a port since the Middle Ages. By 2010 the town's port has become the fourth largest in the United Kingdom in terms of tonnage, and plays an important role in the United Kingdom's energy sector with several oil refineries and one of the biggest LNG terminals in the world.

The South Hook Jetty was originally constructed in the late 1960's and was previously used as an import jetty for crude oil delivered to the refining plant. The structure was mothballed in the 1980's and in the early 2000's the owner wanted to reinstate the facility as a LNG import facility. In 2005 it was identified that the repair and upgrade of the existing jetty was feasible in comparison to demolition and new construction.

A LNG receiving terminal was constructed with a component of the construction program involving the repair and protection of the existing 30 year old jetty facility to provide a further 30 year life to the structure.

The existing jetty is 1km in length comprising 125 separate support structures. The jetty head is a further 1km in length and comprised 5 existing berths that were to be converted into 2 berths.

The construction/ design requirements called for pre-stressed concrete piles with reinforced concrete crossbeams. Existing piles were identified in good condition with extensive repairs being deemed necessary to the reinforced concrete pile crossbeams and existing steel piles with poor existing protective coatings. New steel piles were to be protected with the application of a high quality protective coating system.

The existing structures suffered from chloride contamination providing corrosion of reinforcement and damage to the concrete which had taken place over the life of the structure, and without the installation of a cathodic protection system, the degradation process would continue.

The project works included access requirements, containment of debris, concrete repair and cathodic protection of reinforced concrete pile caps, prestressed concrete piles, repair of old steel piles and installation of new steel piles.

Prior to cathodic protection system installation concrete repairs were undertaken. Firstly a detailed survey was completed and damaged concrete was removed by hydro-demolition. Repairs were made using dry mixed sprayed concrete. Cathodic protection to the concrete reinforcement was achieved using a titanium mesh anode in an overlay of sprayed concrete. Additionally, impressed current water anode cathodic protection was provided to protect underwater concrete and steel piles.


Corroded Rebar & Degraded Concrete.

The sprayed concrete selected for concrete repairs offered improved programme times with no requirement to wait for cure to strike shutters. The material was also suitable for application to irregular geometries, and was cathodic protection compatible with the same material used as the overlay for the titanium mesh anode.


Access System to Piles.


Encapsulation of Headstocks.


Titanium Mesh Installation.


Sprayed Concrete Application.


Sprayed Concrete Application.

The completed project works provides for 12,000m² of concrete protected by titanium mesh cathodic protection and sprayed concrete overlay in 147 anode zones comprising 880 reference electrodes to monitor performance, 342 submerged anodes and 227 submerged reference electrodes.

A1089 Tilbury Dock Road, London

The Port of Tilbury is located on the River Thames in Essex, England. It is the principal port for London as well as being the main port for handling the importation of paper. There are extensive facilities for containers, grain, bulk cargoes and cars. It forms part of the wider Port of London.

The project brief was to carry out concrete repairs and install an impressed current cathodic protection system to various structures supporting the elevated section of the A1089 Dock Road Tilbury.

The specification detailed performance requirements in terms of life of the completed scheme. It was specific in certain respects such as the number of monitoring locations within the completed cathodic protection scheme and the extent of the works to be priced, to be in accordance with the outline brief provided but the design of the protection system was to be undertaken by the contractor.

The project brief in these areas was met, despite a significant increase in the number of concrete repairs and an increase in the scope of the work, which increased the size of the project by 35%. Even with this significant increase in the scope of work the project was completed within 20 weeks, an increase of only 3 weeks from the original programme. This was achieved through good communication and teamwork with all parties, both on site and with the design team which enabled maximum flexibility whilst minimising response times.

Tilbury Dock Road Bridge.

Installation of Impressed Current CP System

Harlech Swimming Pool, Harlech

Harlech is a town and seaside resort in Gwynedd within Merionethshire in northwest Wales. The town is located in the unitary authority of Gwynedd which was formed in 1996.

In 2007, the future of Harlech Swimming Pool, which was built in the 1970s, was in doubt when Gwynedd Council decided it could no longer afford to run it. A community company set up to save Harlech Swimming Pool from closure was established, and in 2010 they were handed the keys to the pool, and had secured grants from the lottery and Welsh Government to fund essential refurbishment works.

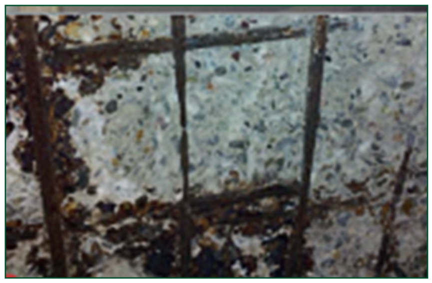
In July 2011 condition surveys of the swimming pool crawl duct walls and soffits were carried out to establish the scope and quantum of repair required to the concrete surfaces.

The survey undertaken included a 100% sounding survey of the service void swimming pool elevations and soffits, a cover meter survey to establish reinforcement density and continuity testing to estimate the extent of electrical bonding that may be required during concrete repair to make the reinforcement compatible with electrochemical repair techniques. Results of the survey found there to be deteriorating reinforcement steel within the crawl duct walls and soffit, along with areas of cracked and spalling concrete. The remediation recommendations put forward a solution of concrete repair and the installation of a cathodic protection system, including the design and specification for the cathodic protection system.

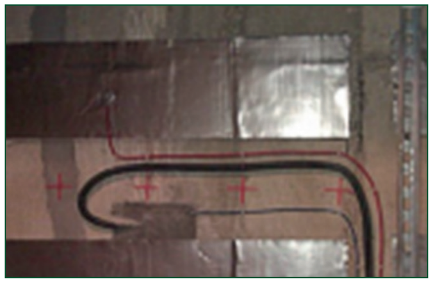
The perimeter crawl ducts where the works were to be carried out were classified as confined space, therefore, careful planning, correct equipment and monitoring and certified personal were all essential to complete the project in a safe manner.

The project was completed in two stages. The break out and removal of delaminated and spalled concrete was followed by testing to ensure continuity of the reinforcing steel prior to the completion of concrete repair works. The repair areas were allowed to cure prior to the installation of a ZLA "sticky zinc" galvanic cathodic protection system. The locations of zinc were marked out on the walls and soffit with small pockets broken out to allow for the welding of studs to the reinforcement before being electrically connected to the ZLA.

Swimming Pool Crawl Ducts.



Corroded Rebar & Degraded Concrete.



Galvanic Cathodic Protection System.

Scotland – Site Visits & Discussion – Challenging Concrete CP Projects

Forth Road Bridge, South Queensferry

The Forth Road Bridge is a suspension bridge in east central Scotland. The bridge, opened in 1964, spans the Firth of Forth connecting Edinburgh to Fife. It replaced a centuries-old ferry service to carry vehicular traffic, cyclists, and pedestrians across the Forth with rail crossings made on the adjacent and historic Forth Rail Bridge. Issues regarding the continued tolling of the bridge, and over its deteriorating condition and proposals to have it replaced or supplemented by an additional crossing, have caused it to become something of a political football for the Scottish Parliament, which eventually voted to scrap tolls on the bridge with effect from 2008.

When the bridge was opened in 1964, it was the fourth longest in the world, and the longest outside the United States, with a main span of 1006 meters between the two towers. In total, the structure is over 2.5km long.

Forth Road Bridge.

In early 2010 refurbishment works on the Forth Road Bridge commenced and included the replacement of bridge bearings, concrete remediation and the installation of an impressed current cathodic protection system to the north and south approach spans to the main structure.

Access:
The remediation works needed to be completed with no disruption to traffic using the bridge which necessitated the need to design special access systems.

Forth Road Bridge Access System.

Movement monitoring of the structure throughout the works was achieved through the installation and operation of an advanced system to record and capture the movement of the structure during the works.

LVDT sensors, pressure transducers, thermocouples and pendulums were installed at each pier location and connected to a host computer in the site office to record vertical and longitudinal movement, temperature, hydraulic pressure in jack stacks (load) and pier verticality.

Data was captured and issued to the project engineer for information and was used to give before and after information for the bearing articulation.

Concrete pier assessment determined that the existing reinforcement was not adequate to resist bursting loads in the pier tops, but the pier was adequate if the tensile strength of the concrete was invoked.

The concrete corbels were designed to be permanent extensions to the existing pier and served two purposes - to provide adequate space to position jacks and to facilitate the installation of permanent bursting reinforcement in the pier tops.

The corbels were required to carry the load from the temporary jacks to allow the permanent bearings to be replaced whilst also allowing the pier top concrete to be broken out and recast where needed to rectify the deterioration. For this reason, the corbels were cast 300mm below top of pier level so that pier top breakout would not undermine the new corbel reinforcement.

Corbel addition within clearance of the inspection gantry.

The inspection and concrete test data indicated that the cause of concrete deterioration was chloride induced corrosion, possibly from the initial use of de-icing salts in the first twenty years of the bridge's life. The chloride ion content at the majority of pier tops and both abutments was in excess of the threshold value of 0.3% by mass of cement and the 'diffusion' calculations suggest that the critical level at the depth of reinforcement would be reached in the next 5 to 8 years.

The application of cathodic protection to the piers, side towers and abutments, together with minimal concrete repairs solely to areas of delamination was evaluated as the most cost-efficient solution for the substructure.

The three types of anode systems used in the design were;

(1) titanium mesh based anode to be installed at the interface of concrete substrate and new corbels

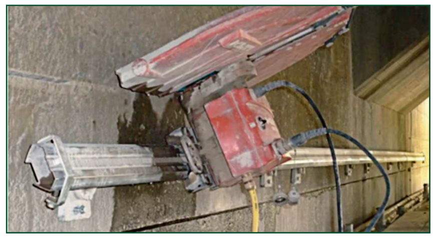
(2) titanium ribbon based anodes to be installed within slots cut into the concrete cover, and

(3) titanium mesh based discrete anodes designed to be installed within holes drilled into the structure.

In addition galvanic anodes were installed into repairs outside the impressed current zones. Reference electrodes for monitoring the performance of each anode zone were also included.

Over 14,000m of titanium ribbon anode strip was installed into the concrete faces of the pier head, cross beams and legs to form part cross beams and legs to form part of the CP system.

Titanium mesh based anode to be installed at the interface of concrete substrate and new corbels.



Titanium ribbon based anodes to be installed within slots cut into the concrete cover.

An innovative technique was designed that utilised a special chase cut into the concrete using a remote operated wall saw. This cut up to 60 metres per day without exposing operatives to excessive hand arm vibration or concrete dust.

The area covered by each anode zone was designed to be independently powered by an integrated power supply and data acquisition unit, which will provide the facility for controlling the voltage and current to each zone; and monitor/control each zone; and monitor/control the performance of the CP system.

All units are installed within two networks (one for each approach viaduct). On each network all units were detailed to be operated from a single main control unit either locally on site or remotely via a modem connection.

Integrated Power Supply & Data Acquisition Unit.

Ireland – Site Visits and Discussion – Challenging Concrete CP Projects

Customs House Docks Development, Dublin

Dublin Docklands is an area of the city of Dublin, Ireland. The Docklands has over recent years been regenerated as an extension of the modern business hub of Dublin. By 2008 the area had over 600 enterprises, however this slowed considerably due to the 2008–2014 Irish financial crisis. The urban regeneration was to transform the Docklands into an innovative built environment and a uniquely modern area in which to do business. New infrastructure has made the area more accessible. Despite the scaling down of projects due to the economic recession the Docklands has become a vibrant working and living district in the city of Dublin.

Customs House Docks Development.

The Custom House Docks Development is a residential structure built on a reinforced concrete support framework of columns and beams within a flooded dock basin.

Surveys of the sub-structure were undertaken following the dock being pumped dry to assess the condition of the concrete particularly in relation to corrosion damage caused by ingress of chlorides from the saline dock water. Following the surveys, proposals were presented to the client and their engineer for the repair of the sub-structures.

These recommendations included concrete repairs and the installation of a cathodic protection system to the effected elements of the structure. A contract was awarded to undertake the concrete repairs, to design and install a cathodic protection system and provide additional structural strengthening in the form of new RC walls as directed by the client's Engineer.

Due to the variation in exposures the cathodic protection system utilised three different anode systems, embedded discrete anodes for atmospherically exposed slender columns, expanded mesh anode and concrete overlay for beam and skirt structures and a series of submerged anodes for the seawater submerged structures.

System Cable Installation.

System Anode Mesh Installation.

I would like to sincerely thank the ACA Foundation for the extraordinary opportunity that the scholarship presented me. I was able in one trip to make connections with a wide range of colleagues and to see some extraordinary places. I can only recommend that other members of the ACA consider applying for a similar grant.

Thanks, **Mike Rutherford.**

Corrosion, the Law and Punishment

Failure of critical infrastructure due to corrosion can be caused by unexpected degradation of materials exposed to aggressive and marine environments, or to corrosive soil conditions. Corrosion of steel structures and assets can be exacerbated by poor design, poor coatings, contaminants present in fluids and aggressive soil around buried structures. Other external influences, such as poor selection of materials or inadequate maintenance can also severely impinge on the life expectancy of a structure. For example, corrosion in a pipeline or underground storage tank can result in spills, leaks, product contamination or even an explosion.

The consequences of an asset failure can cause harm to the environment, property, and to the community. In addition, corrosion damage and failures of infrastructure can expose asset owners to significant legal liability such as an expensive civil court proceeding and even criminal action. If a major failure involving corrosion does occur then a consultant specialising in corrosion engineering may be instructed by a lawyer retained by the asset owner (the client) to help to legally protect the owner's interests.

The client's legal representative having selected a consultant expects unbiased and competent treatment of the issues with an independent report being produced. The consultant's report providing a root cause analysis (RCA) of the failure may later form the basis of a brief of evidence, produced jointly by the consultant and the instructing lawyer, which may be presented in a law court.

Alternatively, an affidavit may be requested, which is a written statement made under oath that can be admitted as evidence in court. It contains written facts that are true to the best knowledge of the person signing the affidavit. Affidavits are commonly used by lawyers to provide sworn statements by individuals in a court. To perform the professional duties expected by the courts a corrosion consultant must have a background in one of the engineering or scientific disciplines. This is often supplemented by continuing education in corrosion control principles and their application in public services, commerce and industry.

A broad engineering appreciation of a specific project is also needed to develop and integrate the most practical and effective corrosion control measures that should be employed in the particular field in question.

During the last decade concerns have developed, particularly in the USA, as to whether owners and operators of important infrastructure and assets which have suffered some degree of corrosion and failure during service, are legally liable to civil and/or criminal action in the courts If the asset that has failed is properly insured, the insurer of the asset (the insurance carrier) will also show a keen interest in determining the cause of the failure in order to minimise any insurance exposure they may be liable to pay out on the insured asset.

In 2007, in response to several prominent corrosion-related pipeline failures, the US government introduced a ruling that individual company personnel, including technical and engineering staff, may be held criminally responsible for an asset failure. This legal ruling raised the ante considerably with the prospect of higher penalties and punishment being enforced on industries and service providers by the US courts.

The US regulators now require proof of higher levels of preparation and performance of corrosion control measures installed on important assets such as pipelines which can carry flammable or dangerous fluids and gases across the country. Under the US ruling, corrosion specialists are expected to do their jobs with precision and accurate documentation.

Management is expected to provide adequate resources to facilitate proper corrosion control activities in a company. Suppliers and vendors of plant and equipment are expected to deliver on their performance promises. Companies are expected to conduct due diligence to ensure that everything is being done to meet regulatory and industry standards and ultimately protect the public from failures. Companies and other organisations have a duty of care to the public and towards the wider community. In tort law, a duty of care is a legal obligation that is imposed on an individual or organisation which requires adherence to a standard of reasonable care while performing any acts that could foreseeably harm others.

Breaching the duty of care may subject an individual or an organisation to legal liability. In a 2010 case in the USA a truck driver was fatally injured while loading his truck under a 150-ton capacity steel road ice salt bin when the bin support structure collapsed and the huge structure collapsed onto the cab of the truck (Figure 1).

The salt bin operator was also seriously injured in the accident after the operator's booth collapsed to the ground. RCA was conducted by forensic experts to determine the cause of the bin failure which was subsequently identified as being due to steel corrosion that had not been addressed by company engineers. Company management did not ensure that adequate safety procedures were in place to properly evaluate and maintain the corroded steel support structures on the salt bin.

The conclusions drawn from the forensic investigation were that the accident occurred because company management failed to ensure that routine inspections were conducted to properly evaluate the salt bin condition. The steel structure collapsed because severely corroded shear tab connections overloaded and subsequently failed. Corrosion prevention measures had not been addressed that would maintain the integrity of the steel support structure of the salt bin.

The company management was found to be grossly negligent and was held legally responsible for the accident during subsequent court action. The company was subsequently required to pay for the errors of their ways. This case illustrates the point that commercial organisations can no longer ignore corrosion and treat it as a natural event to be dealt with if it arises, employing reactive management, viz. wait-and-see what happens over time. If management does not address the corrosion risks that apply in their organisation, through ongoing pro-active management, then they risk the full weight of the law descending on them and their company if a serious asset failure occurs.

Figure 1. Collapse of steel salt bin in US that killed a truck driver. The road salt bin structure failed due to corrosion.

LAW COURT PROCEDURES

The adversarial legal system that operates in many countries is a method of adjudication before an impartial court. There are formal procedural rules with the responsibility on the two parties, usually through counsel, to present their case and challenge the opposition case. The adversarial legal system tries to ensure that, at least theoretically, the truth is arrived at. Before facts are accepted and acted upon in the law court they must be proven.

The purpose of the adversarial legal system is to do just that – to expose evidence through witnesses and documents in court and to persuade the court to accept the arguments and reasoning placed before it by counsel. In civil litigation, where most failures of assets are dealt with, the sides exchange statements of the issues, known as the pleadings, which comprise a statement of claim and a statement of defence in reply.

Nowadays, the pre-trial exchange of briefs of evidence prepared by experts is encouraged to clarify the issues and eliminate any elements of surprise (trial by ambush). Strict rules of evidence apply in court and all evidence presented to the court must be admissible. Evidence is inadmissible in a law court if any of the following apply

- Irrelevant evidence
- Privileged information - confidential to one party
- Evidence without foundation
- Hearsay
- Speculative – not the best evidence available
- Opinion – however, opinion is acceptable from an expert witness

It is the responsibility of the opposing parties to argue the case in court to the required legal standard – beyond reasonable doubt for criminal cases, and on the balance of probabilities for civil cases. In a civil trial a judge hears the matter before a court; the role of the judge is to determine both the legal and factual matters presented by opposing counsel. Thus, the judge is like the referee in a sporting contest. The civil court is legally different to arbitration where the decision in a case is made by a professional arbitrator. Mediation is an alternative dispute resolution process to arbitration, where a decision is made by a third party called a mediator. A tribunal hearing is where the decision on a serious community matter is made by a tribunal.

EXPERT EVIDENCE AND EXPERT WITNESSES

In a civil court expert witnesses are selected by each party in a case and the experts may be questioned (cross-examined) by the opposing lawyer in court. Competency is crucial for giving expert evidence. The more competent the witness, the more credible will be the evidence provided and the more likely it will be that the adjudicator will be persuaded by it.

It is particularly important that the lawyers thoroughly develop the background of the expert witness. All aspects of his/her professional training and credentials that have a bearing on the legal issues in question must be brought out in detail to the court. Also, a thorough and detailed explanation of the expert's opinion will make the evidence more credible.

The secrecy of the adversarial system usually means that an expert witness should not divulge that he/she has been engaged by either party in the case. The secrecy is equally applicable in an engineering dispute as it is in a criminal trial.

Sometimes, expert witnesses struggle with the secrecy approach of the legal system because their engineering or scientific training encourages them to seek the truth and to put out everything they know in the public domain. Lawyers on the other hand are trained to advance the cause of their client who pays their fees.

Sometimes, lawyers will attempt to muddy the waters in a case by persuading an expert witness to tell the truth but perhaps not the whole truth. Furthermore, a good expert witness can win a case for a client without ever needing to appear in court, thereby saving the client a large amount of time and money.

The expert must know all the facts, because the best opinion may be worthless if based upon an incorrect understanding of the facts in a case. In NZ the expert's report is submitted to the client's lawyer setting out all the facts, the relevant issues, and the technical strengths and weaknesses of the case.

The expert's report is initially marked privileged to ensure that the report is protected from the discovery process that lawyers carry out before a civil trial. The forensic report submitted by the consultant will likely become the basis of a brief of evidence in the court.

The expert witness should ensure that the client's lawyer is familiar with all the technical details and terminology of the subject of the forensic report so that the lawyer can cross-examine an opposing expert witness if need be. The expert's report should therefore be thorough, accurate, straightforward, without using too much technical jargon.

The expert witness should not hesitate to refer any specific issue to another expert in the field who may have more expertise and/or experience in some particular aspect of the case. Some tiny area of knowledge in which the expert witness initially engaged is lacking, might once researched be the tipping point in favour of the client and the winning of the case.

High Court Rules: Code of Conduct for Expert Witnesses

An expert witness has an overriding duty to assist a court impartially on relevant matters within the expert's area of expertise (4). The expert witness is not an advocate for his/her client. In fact a partisan expert witness, sometimes referred to colloquially as a hired gun, is really of little use to anyone in a civil court because the judge can rule the evidence given by such a witness as biased or speculative.

For civil courts, in any evidence given by an expert witness the expert must acknowledge that he/she has read the Code of Conduct for Expert Witnesses and agree to comply with it. An expert witness must also comply with any direction of the court to confer with another expert witness and try to reach agreement with the other expert witness on matters within the field of expertise of the witnesses.

The forensic consultant acting as an expert witness must exercise independent and professional judgment and must not act on the instructions or directions of any person to withhold evidence or to avoid agreement on complex technical issues before the court. As to the adversarial system, the best approach for consultants acting as an expert witness is to accept that the adversarial legal system is there, to understand how the system works, and to not remonstrate against the legal system.

INSURANCE POLICIES AND EXCLUSION OF CORROSION

The global insurance industry takes steps to ensure that all-risk insurance policies for structures and assets place corrosion of materials as an excluded risk in policies. For insurance purposes corrosion that occurs on any insured structure is normally classified as wear and tear, unless specific types of corrosion that may happen are defined within the policy. There have been cases reported where insurers have successfully defended the excluded risk despite there being technical evidence presented by experts that a corrosion issue in an insurance policy claim was not due to fair wear and tear.

Where an insured makes a claim for a loss it must first be established whether the insurer is legally liable to pay the claim. If the insurer is liable to pay the claim it must then be established how much the insurer must pay. The term quantum means 'amount' in Latin. In many insurance claims involving corrosion of assets a corrosion consultant will work alongside a Loss Adjuster appointed by the insurer to determine the cause of a particular corrosion issue and to help assess the quantum of any loss due to corrosion and degradation.

The consultant’s report on the corrosion matter in question should be clear, thorough and technically accurate, because the report submitted may subsequently become a brief of evidence in legal action.

Disputed insurance policy claims resulting in legal action are civil cases where the evidence presented by opposing counsel, the insured and the insurer, is weighed up by a judge on the balance of probabilities.

All risk insurance cover – Principles relating to loss due to corrosion damage

Insurance is intended to provide cover against the risk of fortuitous events. The latter is an unforeseen event that occurs by chance or accident from natural or man-made forces over which the affected person has no control. The purpose of insurance is therefore to provide an indemnity against accidents that may happen, not against events which must happen (Figure 2).

Unless the policy provides otherwise, the insurer is not liable for ordinary wear and tear, ordinary leakage, ordinary breakage, inherent vice, or the nature of the subject-matter insured. Inherent vice and wear and tear are often referred to in the same exclusion clause as corrosion or oxidation. Inherent vice is an exclusion found in most property insurance policies eliminating coverage for loss caused by a quality in the property that causes it to damage or to destroy itself.

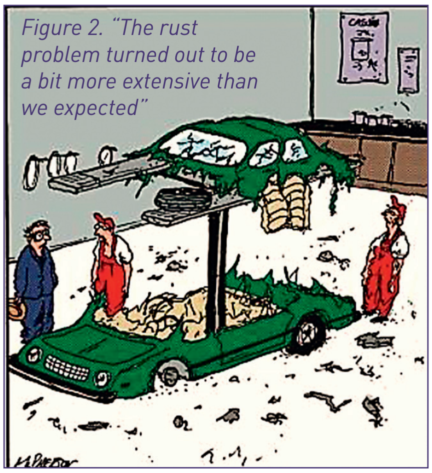


Figure 2. “The rust problem turned out to be a bit more extensive than we expected”

Inherent vice is a hidden defect of goods or property which of itself is the cause of, or contributes to its deterioration, damage, or wastage. Such characteristics or defects make the item an unacceptable risk to an insurer. If the characteristic or defect is not visible, and if the insurer or insurance carrier has not been warned of it, neither of the parties may be liable for any claim arising solely out of the inherent vice.

Law courts also apply the doctrine of proximate cause - what is the proximate cause of the loss and is the proximate (legal) cause of the loss caught by the policy exclusion. The court will look to ascertain the dominant cause of a loss. This is a question of reviewing all the facts relating to the insurance case. The proximate cause is not necessarily the immediate cause of a loss, which is the cause latest in time prior to the loss.

An insurance case in the UK[1] dating back to 1918 created a legal precedent regarding the question of proximate cause; that is, the legal cause of a loss. In this case of a large shipping loss the court decided it was to be answered applying the common sense of a businessman or seafaring man. The approach of the court in this case is a guide to how corrosion exclusions may be construed. Many court decisions have been overturned on appeal showing the difficulties that can arise in construing these types of exclusion and applying them to the facts of a given insurance case.

A further legal case was Navalight Shipping Limited versus Sovag at the Court of Appeal in The Hague, in March 2011. The maritime insurance claim concerned severe pitting corrosion damage that occurred to the ballast tank steel plate inside the bilge area of a large cargo ship (5).

The Ship Class[2] required that the ballast tank steel plate be completely replaced, but the ship hull insurers declined the claim. The insurers successfully denied liability on the grounds that the insured could not prove any recoverable damage during their policy period. The insured contended that the damage to the hull inside the ship was caused by sulphate-reducing bacteria (SRB) present in the ballast tank water and that this constituted a loss by perils of the sea which is an insured loss.

The insurers submitted that the proximate cause of the loss was failings on the part of the insured to protect the ship ballast tanks against SRB attack (microbial corrosion). The Court of Appeal held in favour of the insurers. The court did not consider the origin, cause, or rate of corrosion to be relevant to the issue of the insurance coverage. It was the failure of the insured to put in place measures to prevent SRB damage in the ballast tanks which was the proximate cause of the loss.

Corrosion and the insurance industry
The following list is a summary of the main issues that an insured organisation should be familiar with regarding the loss of assets due to corrosion damage, which are insured under an all-risks insurance policy:

- There exists very little global legal authority on the interpretation of insurance policy exclusion clauses relating to general corrosion.
- The small number of successful appeals on related corrosion cases dealing with wear and tear and inherent vice show the difficulty in applying such clauses to the particular facts in individual cases involving loss due to corrosion damage.
- Ordinary corrosion for all purposes in an insurance policy is wear and tear and the cost of any corrosion damage to an asset is unlikely to be recovered from the insurer.
- Consequential corrosion may be covered by an insurance policy, but this will depend entirely upon the wording of the exclusion clause in the policy.
- The wording of an exclusion clause in an insurance policy will, as a starting point, be legally decisive in a court of law.
- If a loss due to any form of corrosion is caused by gross negligence committed by the insured then the insurance cover may be reduced by the insurer, depending upon the particular circumstances of the loss.

DISASTERS AND PSYCHOLOGICAL STRESS IN COMMUNITIES

Disaster researchers have debated the utility of distinguishing natural disasters from technological (human-made) catastrophies over many years (6). It has been shown that litigation serves as a source of chronic stress for the victims of disasters involved in court deliberations seeking damages or liability subsequent to a major disaster. This is true for large-scale failures due to corrosion involving important infrastructure which produces psychological stress on communities. Unfortunately it has become increasingly clear that large-scale disasters, such as the infamous Exxon Valdez oil spill case in Alaska in 1989, which was not due to corrosion, will remain as a pervasive feature of social life in the future.

Communities damaged by disasters also experience significant impacts from the consequential litigation processes, which in turn can undermine a timely recovery process. The impacts can include disruption of social life, conflict over damage payments, stress from protracted legal procedures, and uncertainty about outcomes of litigation.

Figure 3. The Exxon Valdez oil tanker aground in Alaska in 1989.

Forensic engineering investigations carried out after large-scale failures frequently help to improve the safety of communities and to diminish the psychological stress on people, if the failure occurs to major infrastructure such as bridges or pipelines. Sometimes large-scale asset failures occur due to poor corrosion control or to other human causes.

Law suits filed in the aftermath of large-scale technological disasters are typically complex because of the scientific nature of the factual information and, in many cases the involvement of multiple parties (7). The presentation of high quality RCA for an asset failure assists the court to promptly agree on the cause of the failure and to move forward to assess the liability issues. The sooner a court decision is reached the quicker the community affected by the disaster can recover and move on. Thus, the forensic consultant is duty bound to ensure that the RCA is absolutely correct, the investigation reporting is clear and accurate, leaving little room for doubt in court as to the cause of an asset failure.

LEGAL CASES INVOLVING CORROSION OF MAJOR INFRASTRUCTURE

Many cases of corrosion of infrastructure followed by a large-scale failure and then litigation have occurred around the globe. Quite likely, at this moment in time, litigation is proceeding somewhere around the world for this reason. However, because many law cases involving material failure on structures are settled out of court and are confidential, there are few cases available in the open literature. However, one well known bridge failure case will be outlined, as an example of a large-scale failure and the outcome from the catastrophe involving corrosion (7).

The Minneapolis bridge number I-35W collapse into the Mississippi River in Minnesota USA on August 1st 2007 resulted in 13 deaths and 145 injuries. The 1960s designed steel truss arch bridge was on Minnesota's busiest interstate highway. The eight-lane bridge was in the midst of major deck re-paving when it buckled and collapsed into the Mississippi River during an evening rush hour in 2007. Bridge I- 35W was built with a design life of 50 years but it failed after 40 years in service. The bridge was not scheduled to be replaced until 2020.

State officials had been warned as early as 1990 that bridge I-35W was structurally deficient by the US Federal Government, meaning it needed significant structural repairs. However, the State officials relied upon patchwork steelwork repairs with stepped-up inspection to monitor the condition of bridge I-35W. The outcome of inadequate bridge engineering management (a wait-and-see approach) completely unravelled amid the horrifying plunge of concrete, steel and cars into the Mississippi River on August 1st 2007.

In 1993 bridge I-35 was given a rating of structurally deficient because of corrosion in the steel expansion bearings. Because the deck bearings were not sliding bearings, bridge inspectors concluded that the corrosion observed was not a major issue. Some repairs to fatigue cracking and steel joint corrosion were carried out during the late 1990s and the bridge inspection level was increased thereafter. As late as 2006 a full bridge condition inspection raised no immediate concerns about the bridge condition. The worst nightmare of any bridge engineer occurred shortly after the 2006 inspection when the steel truss bridge failed catastrophically (Figure 4).

Figure 4. Minneapolis interstate highway bridge I-35W collapse in 2007.

In 2008 the US National Transportation Safety Board (NTSB) released initial forensic findings on the bridge failure regarding the areas of load capacity, design issues, computer analysis and analysis of undersize corroded gusset plates. The forensic investigation revealed that photographs taken during a 2003 inspection of the bridge showed some corroded gusset plates were bowing. The root cause of the bridge I-35 failure was later found to be primarily due to undersize gusset plates which were only 13mm steel thick (Figure 5). This was a structural design fault.

Contributing to the design and construction flaws was the fact that 50mm of additional concrete had been added to the road surface over years, increasing the bridge dead load very significantly. Also contributing was the weight of construction equipment resting on the bridge just above its weakest point (gusset plates) at the time of the collapse. The NTSB eventually determined that corrosion was not a contributing factor in the bridge failure. Furthermore, bridge inspectors did not routinely check that all the bridge safety features were fully functional.

The collapse of the bridge seriously affected river, rail, road, bicycle, pedestrian transportation and air transit for several years after the event. Psychological stress in the local community was very high for the victim's families, workers who lost their livelihoods, and many businesses that were severely affected by the loss.

Forensic investigation was carried out on the collapsed steel bridge by an independent firm of failure analysis specialists. Using the forensic engineering reports, litigation and determination of liability for the bridge collapse proceeded in court for the next four years, from 2008 to 2012. In 2011 a lawsuit brought by the State of Minnesota against the original engineering firm that designed the I-35W steel truss bridge in the 1960s was still pending. In May 2012, the US Supreme Court rejected an appeal by the bridge construction firm who argued that too much time had passed since the 1960's design work. This legal decision allowed the State of Minnesota lawsuit to proceed. To avoid protracted litigation, the engineering firm paid $US9 million in compensation in November 2012 to settle the lawsuit without admitting any wrongdoing.

The total cost of the I-35W bridge collapse may never be known, but legal costs arising from the bridge failure alone were over $US60 million. The replacement interstate highway bridge built adjacent to the original I-35W bridge at Saint Anthony Falls on the Mississippi River was completed by 2008 and it cost around $US300 million to build.

Figure 5. Bridge I35W steel gusset plate showing cracking and corrosion [7].

A major benefit to all US communities that arose from the collapse of bridge I-35W was that in the aftermath the Federal Highway Administration (FHWA) instructed all US States to totally inspect 700 additional highway bridges with similar steel truss arch construction of about the same age as bridge I-35W. The US government warning specifically related to the steel gusset plates used to connect steel girders together in many existing truss bridge structures. Officials also expressed grave concern regarding many other bridges in the US that shared the same engineering design defect. They raised questions as to why such a serious design flaw had not been discovered after decades of truss bridge inspections. The design oversight was probably contributed to by the 'wait-and-see' damage control approach to infrastructure management that prevailed in the US in the last century. The bridge gusset plate design defect and its susceptibility to localised corrosion if fatigue initiated was first identified by the independent consulting firm employed by the Minnesota Department of Transport (DOT) to determine the cause of the I-35W bridge failure. In many ways it was fortuitous that only one of 700 forty-year old US steel truss bridges of similar design had collapsed due to fatigue and/or corrosion during the 40 year period of service.

The role of forensic investigators with expertise in metallurgy and corrosion engineering contributed a great deal to ensuring that the catastrophic bridge failure was overcome as rapidly as possible for the community involved. The loss of human life was tragic, and this will always be remembered, but the Minnesota community has slowly recovered from the fatal loss of a piece of critical infrastructure and it has moved forward again. And, civil law ensured that those found to be responsible for the bridge failure received appropriate punishment.

CONCLUSIONS

1. The adversarial legal system that exists in many countries can be a daunting environment in which to work for a corrosion consultant or expert witness with an engineering or scientific background.

2. The lawyers are in a civil court to win the case for their client, but the consultant's role is to assist the client, the lawyer, and the judge to determine the truth about the cause of an asset failure.

3. The consultant has to determine the root cause of failure of the asset by carrying out a forensic investigation based upon all the facts and evidence available.

4. The investigation report prepared by the consultant may become a brief of evidence to be presented by the consultant as an expert witness in the court room.

5. The legalities of the case are fought over by legal opponents in the court but the outcome may solely depend upon the quality of one consultant's expert evidence.

6. Often law cases are settled out of court and because of confidentiality agreements the consultant acting as an expert witness may never find out how much the evidence he/she presented had counted in the legal decision.

7. Some cases are too scientifically complex for lawyers to comprehend and the judge may make a decision based upon the legalities of the case and not upon the technicalities presented.

8 Corrosion and metal fatigue have featured in many infrastructure failure cases which have cost companies, organisations and communities vast sums of money to litigate and settle.

9. The human psychological stress engendered by a major asset failure can be very extensive in the aftermath of such an event. A prompt outcome that resolves some legal matters as to cause and liability is beneficial to all concerned. Consultants acting as expert witnesses aid the legal process.

10. Monitoring and inspection of infrastructure to assess their existing condition is a vital part of the engineering management of structures. A wait-and-see monitoring approach for infrastructure poses a higher risk to the asset's likelihood of failure caused by fatigue or unseen corrosion.

11. Personnel involved in asset condition assessment have a duty of care to the asset owners and to the public alike. Engineering staff must ensure that critical structures are routinely inspected and monitored to make sure that problems such as corrosion and/or fatigue of metal structures are not occurring during service.

REFERENCES

[1] Forensic Corrosion Engineering, A. Spowage, Corrosion & Materials, Australasian Corrosion Association, Vol.38, No.6, pp 35-39, December 2013.

[2] Corrosion and Punishment, Pipeline and Gas Journal, Vol. 239, No.3, USA, March 2012.

[3] The Adversary System in Courts and Tribunals, D. S. Firth, Seminar on Expert Evidence, Centre for Continuing Education, Auckland University, September 1990.

[4] Code of Conduct for Expert Witnesses, McGechan on Civil Procedure, Justice R. A. McGechan, Thomas Brookers, New Zealand, 1985.

[5] Corrosion and Exclusion Clauses– an English Law Perspective, P. Foss, Norton Rose Fullbright, Proceedings of Lillehammer Energy Claims Conference, Norway, March 2013.

[6] Disaster, Litigation and the Corrosive Community, J. S. Picou, et al, Social Forces, Vol. 82, No.4, pp 1493-1523, June 2004.

[7] I-35W Mississippi River Bridge, Wikipedia Encyclopedia, 2014, www.wikipedia.com

ACKNOWLEDGEMENT The author is not a lawyer and a number of the legal cases outlined in this paper, the images presented, and background legal information have been sourced from the Internet. In particular, the author acknowledges wikipedia.com

Footnotes

1. Leyland Shipping Co Ltd versus Norwich Union Fire Insurance Society Ltd, UK, 1918.

2. A Classification Society is a non-governmental organisation that establishes and maintains technical standards for the construction and operation of ships and offshore structures. The Society will also validate that construction is according to these standards and carry out regular surveys in service to ensure compliance with the standards.

L. H. Boulton
Les Boulton & Associates Ltd
Auckland, New Zealand

This paper was originally published in the Corrosion & Prevention 2013 proceedings.

Condition Assessment and Asset Management of Water Storage Tanks

D.P. Ferguson
Infracorr

1. Introduction

1.1 Background

There are currently over 35 public water authorities across Australia, with 19 in Victoria [1]. Together, these organisations are responsible for delivering a reliable potable water supply to the majority of Australia's towns and cities. Treated water supply storage tanks typically have capacities that vary from tens of kilolitres to tens of megalitres, and are an important part of the infrastructure utilised in the drinking water delivery process, storing treated water and providing water pressure (in the case of elevated storages). In addition, many industrial and private organisations own and operate similar large water tanks. Such water tanks are typically cylindrical in shape for structural efficiency and are constructed from a variety of materials including glass reinforced plastic (GRP), high density polyethylene (HDPE), iron, steel, stainless steel, reinforced concrete and pre-stressed or post-tensioned concrete. Combinations of materials may be used, such as a concrete floor and steel walls. Tanks are typically roofed to maintain water quality, and a similar variety of materials are used to construct these. Larger capacity storages of greater than 100 megalitres are typically mass or reinforced concrete, earthen embankments or dam structures.

Asset management of a water storage tank portfolio can be complex with a range of tank types, condition status, and operational constraints, ensuring that an individual approach is required for each storage tank, together with a systematic way of ranking tanks in the portfolio for planning future maintenance and renewal. Tank construction type and specific combination of materials are key variables affecting this process; each construction type is affected by an array of possible deterioration mechanisms and remediation options. This is further compounded by the question of timing: to repair now or delay and repair/replace later?

Hence the identification and remediation of deterioration (including corrosion related defects) is only one step in the asset management challenge faced by infrastructure owners. This paper describes common defects/deterioration observed across a range of water tanks, and a process to review remedial options and develop a maintenance strategy.

1.2 Basis of the Review

This paper draws the author's observations gained from inspections of over 50 water storage tanks owned by five water authorities within Victoria over the course of three years. The water tank construction types inspected, and discussed in this paper include:

- Reinforced concrete tanks
- Bolted steel tanks
- Welded steel plate tanks

The water tanks were located at ground level or elevated. Elevated tanks are typically constructed on top of a concrete tower or a galvanized steel support stand up to 20 m high. Ground level tanks typically have a large diameter to height ratio. Conversely standpipes (steel or reinforced concrete) typically have a large height to diameter ratio.

The level of detail of site condition assessment varied between tanks depending on the requirements of the asset owner. Some of the tanks were assessed using a high level approach – only a visual inspection (internal and external) to identify key defects and potential deterioration mechanisms – while others were also subject to detailed forensic testing both destructive and non-destructive. The level of detail in the final remedial works recommendation was largely dependent on the thoroughness of the condition assessment. A high level visual inspection allows observation of accessible, visible defects but may not allow identification of the root deterioration mechanism. With suitable inspector experience, some likely deterioration mechanisms could be identified, with further inspection/testing required to confirm any hypotheses.

In some cases internal inspections were undertaken with tanks emptied, whilst commercial divers inspected others while in service.

Figure 1 Typical reinforced concrete water tanks inspected as part of this case study.

Figure 2 Typical steel water tanks inspected as part of this case study.

2. Observed Deterioration/Defects

The water tanks assessed can be broadly classed in two categories, concrete tanks and steel tanks, as many deterioration mechanisms are common within these categories. In addition, common components including tank stands, roofs and access systems were assessed. The deterioration mechanisms that affect both reinforced concrete and steel materials are well established and are not explored in depth in this paper, however an overview of the commonly observed deterioration mechanisms has been included.

2.1 Concrete Tanks: Typical Observed Defects and Associated Deterioration Mechanisms

The concrete tanks inspected varied in age from under 20 years to over 80 years, and the tanks varied in states of repair from well maintained and refurbished, to highly degraded and decommissioned. Decommissioned water tanks/towers are occasionally left in place as it avoids demolition costs. One such tank was inspected as deterioration could pose a safety risk to both operational staff and the public.

2.1.1 Concrete Cracking

Concrete cracking and associated symptoms including leaking and efflorescence were commonly observed across the inspected tanks. Cracking can be associated with a range of deterioration mechanisms, and in some cases, the underlying cause also requires treatment. Deterioration mechanisms that can lead to cracking include:

- Reinforcement Corrosion
  Reinforcement corrosion was not a common cause of cracking [2] observed in water tanks in the regional areas. This is attributed to generally benign external environments and low chloride levels in the potable waters, as well as low carbonation rates in tank walls that are mainly subject to high water levels and hence high internal relative humidity. Where reinforcement corrosion was observed it was typically associated with localised, very low reinforcement cover, or regular wetting/drying cycles. Delamination and spalling of concrete were associated defects observed alongside reinforcement corrosion. Figure 3 is an example of observed reinforcement corrosion associated with low concrete cover.

- Early-age Thermal Restraint or Drying Shrinkage
  Vertical early age thermal cracking is a common defect in the walls of concrete water tanks due to high restraint from the tank base during casting [3]. Early age drying shrinkage is also a common defect, often due to adverse environmental conditions during construction (hot dry winds during summer), combined with insufficient reinforcement for effective crack control. Such cracks can be exacerbated during service from thermal expansion/contraction effects and changing stress states during tank filling/emptying. Figure 4 is an example of reinforced concrete tank walls with early age thermal restraint cracking.

- Construction Joints
  A number of older water tanks had ill-formed construction joints and localised poor compaction. Insufficient or defective waterstop systems installed at construction joints can also contribute to water leakage at these locations, and in floor joints. Figure 5 is an example of water leakage and efflorescence at horizontal construction joints on an elevated water storage tank.

- Alkali Aggregate Reaction (AAR)
  Signs of AAR [4] were observed only in older structures; plausibly because in these older structures the reaction has had time to develop, conversely in more recent construction aggregate is screened for reactivity. Concrete constructed from locally sourced aggregates in regional areas is often susceptible to AAR and this is consistent with observations. AAR was not seen to be a common cause of deterioration. Figure 6 is an example of suspected AAR cracking of a concrete tank constructed from locally sourced aggregate.

In most cases, concrete cracks were not considered to be the limiting factor with respect to remaining structural life of the tanks, however reinforcement corrosion resulting from cracks was expected to result in continued deterioration which could be more expensive to repair in the future than undertaking less extensive minor repairs when identified. Water leakage at cracks and defective joints is undesirable for serviceability reasons and, if leakage rates are high, for operational reasons.

Figure 3 Reinforcement corrosion resulting in spalling concrete on external tank wall.

Figure 4 Cracking caused by early age thermal restraint in a reinforced concrete tank.

Figure 5 Water leakage and efflorescence at horizontal construction joints.

Figure 6 Suspected AAR cracking of concrete water tank constructed from locally sourced aggregate.

2.1.2 Efflorescence
Efflorescence is observed almost universally where water leakage through concrete occurs. The formation of efflorescence, a hard white chalky deposit on the external surface of the tank, was observed at many of the inspected concrete cracks.

Efflorescence is a symptom of concrete cracking and in itself is not harmful to the structure. Efflorescence results from water leaking through the joint and leaching (absorbing) calcium compounds, predominantly calcium hydroxide. These alkaline compounds then react with carbon dioxide at the concrete surface to form the carbonate salts observed as efflorescence [5].

The formation of efflorescence can cause leaking to cease due to self-healing in narrow static cracks. Self-healing generally occurs within one to two years of construction. Cracks observed leaking in older tanks are highly unlikely to cease leaking due to the long term leaching of the concrete components that develop the self-healing characteristics. If left untreated, structures with efflorescence will continue leaking for the remainder of their service life, and leakage rates may increase slightly due to soft water attack on the crack walls, leading to gradual widening of the cracks. Ground water in Victoria is typically soft and tends to leach alkalinity easily from concrete.

2.1.3 Other Causes of Water Leakage
Combined with concrete cracking and/or poor construction joints, the failure of an internal render or coating was found to be a common cause of water leakage on elevated concrete tanks. In these cases identification of specific defects in the render can be difficult, and complete replacement of the lining material is often required to ensure leakage is mitigated.

The joints between the tank walls and floor leaked in many cases, and past repairs to such joints were often found to have been ineffective.

2.1.4 Effect of Water Leakage
Leaking cracks reduce the effective service life of a water retaining structure. Depending on the circumstances, the amount of acceptable leakage will vary. It is difficult to predict the rate at which the water leakage will increase, thus if cracks are not repaired it is recommended that leakage rates are monitored closely for any changes.

As well as causing reinforcement corrosion at the crack site, leaking water may also accelerate corrosion at wetted areas, such as tower walls, if the structure reinforcement is at risk of corrosion due to existing carbonation, and it can also lead to debonding of render on water tank and tower surfaces. Water leakage through ground tank floor joints can lead to undermining of the foundations and potential structural movement.

2.2 Steel Tanks: Typical Observed Defects and Deterioration Mechanisms
The steel tanks inspected varied in age from under 20 years to up to 50 years of age and the tanks varied in state of repair from the well maintained and refurbished to the highly degraded and requiring replacement.

2.2.1 Atmospheric Corrosion
Steel tanks inspected were protected from atmospheric corrosion by an external coating such as hot dip galvanizing or a polymer coating such as PVC or polyurethane. Coating degradation occurs naturally with time and atmospheric exposure and substrate degradation begins once local coating defects occur.

Atmospheric degradation of the galvanizing layer, such as that shown in Figure 7, is expected to proceed relatively uniformly across the exposed surface area, although micro-environments such as those caused by localised wetting/drying, differential weathering and other changes in conditions results in accelerated localised corrosion [6]. Localised consumption of galvanized coatings was often attributed to an additional deterioration mechanism, such as dissimilar metal corrosion. There was no evidence of maintenance to the galvanized coating on any galvanized steel tanks inspected.

External applied organic coatings were generally found to be in good condition, sometimes despite the overall tank condition.

2.2.2 Dissimilar Metal Corrosion
Dissimilar metal corrosion [7], which could be considered an obvious corrosion risk, was found to be a surprisingly common deterioration mechanism in the tanks inspected. Welding of stainless steel pipes and ladders to galvanized or mild steel tanks results in preferential corrosion of the galvanized or mild steel. One example is shown in Figure 8. This effect was amplified where the tank was coated internally and accelerated corrosion occurred at coating defects due to the large cathode, small anode effect.

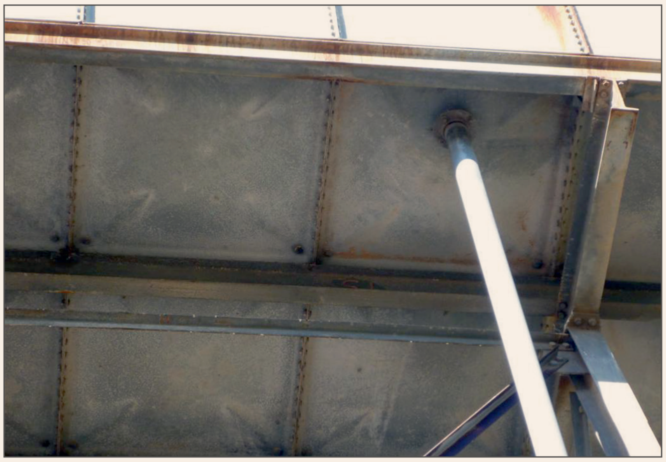


Figure 7 Atmospheric corrosion of galvanized coating, accelerated by the micro-environment on the underside of the tank (condensation, sun exposure etc.).

Figure 8 Dissimilar metal corrosion of a mild steel flange plate that is welded to a stainless steel pipe. Pipe appears to be insulated from the tank.

2.2.3 Bolted Tanks

Common deterioration mechanisms were observed for a number of tanks with walls and floor constructed of steel plates coated on both sides with an organic coating and bolted together with a rubber gasket and internal and external galvanized steel battens. All tanks of this construction were between 25-35 years old, and exhibited similar deterioration mechanisms.

- Coating Failure – Immersion Service

  Internal blistering (shown in Figure 9) of the protective coating in the vicinity of bolted connections were observed on the walls of all similarly constructed tanks. The blisters are considered to be caused by undercutting of the protective coating at drilled/punched bolt holes. Additional local coating stress may have been introduced by the twisting of the nut and bolt during tightening during construction.

  As the blistering was typically observed to be intact, the extent of corrosion of the plates beneath the coating could not be assessed from the visual inspection without removal of the coating (not undertaken). No significant leakage was observed on a tank of this construction, however weeping around bolt holes, and corrosion of selected external nuts and bolts was observed.

  This deterioration mechanism is expected to reduce the life of the tank significantly compared with the service life expectation of the coated steel plate itself, which was predominantly in good condition.

  This type of water tank was at high risk of increased leakage if emptied for inspection, as the removal of water pressure in some cases enabled small movement of joints, which did not re-seal correctly on re-filling.

- Cathodic Protection Systems

  A number of these bolted, coated steel tanks were fitted with impressed current cathodic protection (ICCP) systems.

  The suitability of an ICCP system for a bolted, coated steel tank is questionable for a number of reasons. The tanks are constructed from coated steel plates, connected with bolts and battens and each bolted connection has a rubber gasket, which acts as an electrical insulator. For an ICCP system to operate successfully, all elements to be protected are required to be electrically continuous.

  Observed corrosion of immersed galvanized steel elements (bolts and battens) was observed in all bolted, coated steel tanks with ICCP systems indicating that the ICCP systems, where active, were not successfully protecting the steel elements, and in fact may be increasing the rate of corrosion at coating defects, although verification of this was beyond the scope of the inspections.

2.2.4 Welded Tanks

Welded steel standpipes were protected by an external protective coating, and were typically found to be in good condition. Evidence of on-going maintenance to the external protective coating was observed at these locations. Internal diver inspections identified minor degradation of the internal protective coatings however a cathodic protection system was in operation at these locations protecting the internal steel work from corrosion. Correct operation of the cathodic protection system including on-going maintenance and monitoring, was considered critical to prevent corrosion of the internal walls.

2.3 Roofs and Tank Stands: Typical Observed Defects and Deterioration Mechanisms

2.3.1 Tank Roofs

The most common roof construction for water tanks, for both reinforced concrete and steel tanks, consisted of galvanized steel purlins, beams and sheeting. Support columns included hollow steel sections and reinforced concrete columns. The structural arrangement varied from tank to tank depending on the span of the roof.

The underside of the roofs were subject to aggressive conditions; water condensation, chemical attack from chlorination and design factors, such as restricted ventilation and crevices, combined to result in high corrosion rates. C- and Z-section purlins were exposed to attack as they feature horizontal surfaces with lips from which water does not drain. The water accelerates localised corrosion of initially the galvanized coating and subsequently the steel section as shown in Figures 10 and 11.

The corrosion rates of roof components were dependent on a range of factors, of which one of the most important was available ventilation (reducing condensation). As a result, deterioration varied widely between tanks, and between different micro-environments within a particular tank.

Aluminium roof sheeting with galvanized purlins is a less common alternative design that is expected to be more durable than galvanized roof sheeting. They are, however, subject to other deterioration mechanisms including galvanic corrosion due to dissimilar metals (fasteners and other fixtures) if not correctly installed and this was observed at one location.

No structural analysis of the roof rafters and purlins was undertaken to calculate the residual structural capacity of the roof (where corrosion of the internal purlins has been observed), however a based on previous structural assessments for similar structures, purlins that had suffered perforation of the full width of the lower flange were considered to have potentially lost significant structural capacity, and load restrictions and remedial works for these tank roofs were recommended.

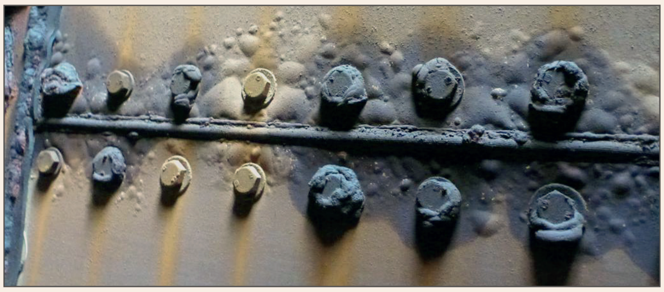


Figure 9 Blistering of internal coating at plate edges / bolt holes following immersion service.

Figure 10 Corrosion of tank roof purlin a galvanized C-section.

Figure 11 Corrosion of tank roof purlin, a galvanized Z-section, with complete section loss.

2.3.2 Tank Stands

Tank stands for elevated steel tanks were constructed in all cases using hot dipped galvanized structural steel. The tank stands were all of similar construction; diagonally/horizontally braced steel columns supporting a tank platform constructed of steel purlins and coated steel sheeting. All steel components were galvanized and pipework penetrated the platforms as required. Consumption of the galvanizing due to localised and atmospheric corrosion was the most common deterioration mechanism observed.

The stands inspected were typically in good condition with only minimal consumption of galvanizing observed and evidence of steel corrosion limited to localised areas on a handful of structures. Sections of the tank stands subject to certain micro-environments were subject to higher corrosion rates than the bulk structure (i.e. the underside of angles which are not naturally washed by rain, and areas subject to water leakage), however this was only observed as localised consumption of galvanizing and surface corrosion.

The condition of tank stand platform sheeting at a number of tanks was observed to range from no observed deterioration to corrosion causing significant section loss and perforation. This advanced deterioration was attributed to the thinner galvanizing coating on in-line galvanized products as well as the increase in risk of wetting on the upper horizontal surface due to rain/tank leakage (particularly if the drainage is inadequate) and/or condensation on the soffit. One example of advanced corrosion of tank platform sheeting is shown in Figure 12.

No evidence of previous maintenance of the galvanizing was observed at any location, on either the tank stand or platform sheeting.

No structural analysis was undertaken to determine the level of steel loss allowed for by the design, however at the rates expected, surface rusting of the tank stand was considered a good early warning of an imminent durability risk.

Figure 12 Corrosion of tank stand platform sheeting.

3. Commonly Available Remedial Options

For the various tank construction types and defects, there are many available remediation options. Table 1 provides some information regarding the most common options that were considered for various tanks assessed. A detailed review of these methods is beyond the scope of this paper.

Table 1 Available Remedial Options.

Concrete Tanks		
Electrochemical Repairs ■ Impressed Current Cathodic Protection ■ Galvanic anodes in patch repair ■ Hybrid anode CP ■ Re-alkalisation	**Crack/Joint Sealing Systems** ■ Rigid epoxy ■ Flexible polyurethane ■ Sealants ■ Crystal growth materials ■ Bandage systems ■ Reinstate water stop system	**Internal Liners** ■ Cementitious based liners ■ Rigid organic liners ■ Pre-formed elastomeric membranes ■ Liquid-applied elastomeric membranes
Conventional Patch Repairs ■ Cementitious materials ■ Partial demolition/ rebuild	**External Coatings** ■ Anti-carbonation ■ Corrosion inhibitors ■ Waterproofing Agents (i.e. silanes and other concrete sealers)	**Replacement** ■ Like with like ■ Alternative capacity/ materials, etc.
Steel Tanks		
Electro-chemical Repairs ■ Impressed Current Cathodic Protection ■ Galvanic anode CP	**Internal Liners** ■ Rigid organic liners ■ Pre-formed elastomeric membranes ■ Liquid-applied elastomeric membranes	**External Coatings** ■ Planned maintenance of coating
Replacement ■ Like with like ■ Alternative capacity/materials, etc.		
Tank Roofs / Stands		
Coatings ■ Planned maintenance of existing coating	**Component Replacement** ■ Sheeting ■ Individual elements (i.e. purlin) ■ Ladders/access systems	**Complete Replacement** ■ Like with like ■ Alternative materials (i.e. aluminium roof sheeting)

4. Identification of Suitable Options
Once the critical deterioration mechanisms were determined and a range of technically suitable repair options identified, the process to select the preferred option was undertaken. The preferred option was often considered the option identified as most economical however, in some cases, a range of social, environmental and other risk factors were also considered.

Steps in the identification process included:

- Review requirements of the asset owner
- Assessment of Technical Risk of Remediation Options
- Whole-life Cost Assessment
- Triple Bottom Line Assessment (if required by asset owner)

4.1 Requirements of Asset Owner
The selection of remediation options is dependent on the requirements of the asset owner, as well as tank specific operational requirements. Factors such as cost, time and technical risk need to be balanced to identify suitable options for each individual project. The typical requirements for remediation works were:

- Remediated structure to achieve a minimum service life extension, typically 20 years.
- Low initial cost options were preferable
- Shortest practical downtime of tank
- Minimise on-going maintenance costs (lowest Net Present Cost)

Individual tanks could be subject to specific restrictions, such as an inability to take the structure off line due to lack of operational redundancy or high local water demand, local construction restrictions (nearby power lines) or future area growth requiring upgrade planning. Depending on the tank condition, replacement options were considered as a serious choice in some situations.

4.2 Assessment of Technical Risk of various repair/ remediation options
The common remediation options were assessed for technical risk based on:

- Review of past jobs/case histories
- Technical assessment of technology
- Innovative use of existing options

This assessment consisted of both an overarching assessment of the remediation option and an assessment of the option at a tank specific level.

One difficulty encountered was accessing relevant information about failed or unsuccessful previous remediation works, although it was found that many contractors were willing to identify situations where certain products would not be a suitable option based on their past experience.

4.3 Whole-life Cost Assessment
After undertaking the technical risk assessment, multiple technically suitable options remained available. Typically three technically suitable options were assessed for Whole-life costs using a net present cost (NPC) tool. Various NPC tools are available; some are developed commercially or within industry. NPC is defined as the discounted present value of the flow of all expense including capital outlay over the evaluation period for the asset [8]. This is calculated using a predicted inflation rate and discount factor. An in-house developed tool was used in this case study.

A Whole-life cost assessment involves identifying the whole of life costs for a remediation option, including timing of future maintenance or replacement costs, to assess the total cost of the option over a set time period, in this case 50 years. This enables the life expectancy of the assessed remediation or replacement options to be assessed on an economic level. The tool allows calculation of both actual total cost (in current dollars) as well as calculation of the NPC based on a predicted inflation rate and discount factor.

4.3.1 Whole-life Cost Assessment: Lessons Learnt
Whole-life Cost Assessment was shown to provide a fair cost comparison of options with major costs being accounted for. It was important to understand that the accuracy of input costs affected the accuracy of output costs. That is, if the cost estimates accuracy was say within ±25%, then the Whole-life cost outputs would at best be within that range, and at worse could be distorted by the use of discount factors and interest rates. Budget costs estimates are typically derived based on experience of previous similar projects and industry cost estimating guides. Some advantages and disadvantages of this process that were identified are listed in Table 2.

The accuracy of the cost estimates can be improved by involving contractors/suppliers, and by preparing a concept design for costing by a quantity surveyor.

Table 2 Advantages and Disadvantages of Estimating Whole-life Costs.

Advantages	Disadvantages
Assessment of whole of life costs and ranking/ comparison of various options	Accuracy of cost estimates, which are based on a combination of project experience, contractor estimates and available guidelines, not tendered quotes
Comparison of immediate versus delayed costs, and assessment of the benefit of delaying costs in terms of net present cost	Requires a prediction of future condition for maintenance costs and planning
The LCCA produces a preliminary time based budget plan which can be incorporated into future capital and maintenance budgets	Extrapolation of maintenance costs may not be accurate, as maintenance frequency may vary and new options may be developed
The comparison can be as detailed or as high level as required by the asset owner – with a good understanding of the project all major costs can be identified	Variables such as interest rates and discount factors are a best estimate, and fluctuate with time

4.4 'Triple Bottom Line' Assessment
As the final method for identifying the one preferred option, a triple bottom line (TBL) assessment tool was utilised in some cases to compare the three technically preferred options. A TBL assessment (also known as a "People, Planet, Profit" assessment) is an assessment of an option not only against the economic bottom line (cost) of a project but also against environmental and social factors. Each bottom line can be assessed against a set of criteria applicable for a particular project.

Assessment criteria were identified for each of the economic, environmental and social bottom lines and each criterion was assigned a weighting. The ranking criteria were established with the relevant water authority through consultation and the adoption of their standard risk assessment matrix prior to undertaking the assessment. Table 3 contains some common criteria, some of which were used when undertaking the TBL assessments.

Table 3 Commonly Identified Risk Factors for TBL Assessment.

Bottom Line	Common Risk Factors
Economical	Initial cost outlay
	Total life cycle cost
	Net present cost
	Project risk
Social	Impact on public i.e. construction
	Service disruption
	Service improvement from remediation
	Water Authority reputation
	Safety
Environmental	Water supply quality
	Impact of remediation works on environment
	Choice of remediation materials
	Water or energy consumption

The three selected options were scored on a simple scale, such as -5 to 5, where 5 is the best possible outcome, 0 is a neutral outcome and -5 is the worst possible outcome in for each criterion. A weighted average, or TBL score, based on the ratings, was output for each option. These scores were then used to identify the preferred option for each water tank.

The results of the TBL assessment varied between assets, with some assessments providing a clear choice, while other assessments identified multiple choices as being of similar impact to the triple bottom line. Where multiple tanks were assessed for the same water authority, near identical TBL criteria were used for the assessment of each option (criteria developed for the specific needs of the organisation). This resulted in similar options being identified as a preferred solution for multiple tanks. This was not considered to reflect a failure on the part of the TBL assessment as it indicates the selected option was the most suitable for the requirements of that organisation.

4.4.1 TBL Assessment: Lessons Learnt

The scope of a TBL tool can be as narrow or broad as desired for a particular project. Criteria can be restricted to known or important variables and a 0% weighting assigned to any criterion not required. The criteria can be customised to align with the core business principals of an organisation, and may be adjusted to fit a particular project based on unique risk factors. Often an asset owner will have a standardised criteria and weighting approach to be used if TBL assessment is undertaken.

A TBL assessment can appear quite complicated at first sight, however a stakeholder workshop can greatly assist with increasing the understanding of not only the criteria used, but also the appropriate ranking and method of calculation. When used with relevant criteria and accurate weightings, a TBL assessment can be a powerful assessment tool.

Ranking of the criteria during assessment can have an element of bias based on the assessors understanding of a project or option. Two TBL assessments with the same criteria and same options could produce different results if the assessors place different value on any particular criterion, particularly if it is heavily weighted. Undertaking the TBL assessment in duplicate (by different assessors) or as part of a stakeholder workshop is one way to identify any bias prior to making the final recommendation.

5. Maintenance Strategy

For the consultant, the condition assessment process can often end with reporting on the options assessment, and the identification of a preferred option for a particular asset. For the asset owner however, the next step is just as important as those discussed above, and the design and implementation of a well-planned and effective maintenance strategy based on the recommendations is a role often undertaken in house by an asset management team. It is important that the outputs of the condition assessment process are in a format that can be readily used for this next project step.

Recommendations for future inspection and maintenance, particularly the timing of costs identified in the Whole-life Cost Assessment, can be used to assist with preliminary budget planning, not just for coming financial years, but also for future Water Plans. By prioritising works across a portfolio of water tanks, the condition assessment report can integrate with the asset owners maintenance program.

Many water authorities now utilise an asset management database which records information for each asset, including results of past condition assessment and details of remediation works. By incorporating past information into updated condition assessments, changes in asset condition over time can be identified, helping to predict future service life in this, and other, assets.

6. Conclusions

Conclusions drawn from this review are:

- The use of an experienced team to conduct the inspection (asset management survey or condition assessment) is an important part of ensuring consistency of reporting and recommendations;
- Using a standardised system for condition assessment and documentation ensures consistency between assessors and between assessments, allowing easy comparison of past and current condition;
- The condition assessment process involves more than just inspecting and understanding the problem - identifying the best solution is a large part of the project;
- Understanding the requirements of the asset owner is key to identifying suitable options amongst the myriad of options available;
- No two tanks are the same; even similar deterioration mechanisms manifest differently and could require different remedial options; and
- Whole-life costing and TBL assessment can be effective methods to identify the best solution for the particular needs of an organisation.

8. References

[1] Victorian Water Industry Association Inc.: http://vicwater.org.au/water-industry-links, last accessed 19 August 2013.

[2] BRE Digest 444, Corrosion of steel in reinforced concrete, Part 1 Durability of reinforced concrete structures, London, 2000

[3] Bamforth PB, Early-age Thermal Crack Control in Concrete, CIRIA C660, London, 2007.

[4] Institution of Structural Engineers, Structural effects of alkali-silica reaction: Technical guidance on the appraisal of existing structures, Report of an ISE task group, London, SETO Ltd, 1992.

[5] The Concrete Society, Visual concrete – Weathering, stains and efflorescence, CS 173, Surrey, 2013

[6] AS/NZS 2312:2002 Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings.

[7] ASSDA, Galvanic / Dissimilar Metal Corrosion, Technical FAQ No. 1, Edition 2, 2009

[8] Leslie H, and Potter R, Glossary of Building Terms, National Committee on Rationalised Building and Standards Australia, Sydney, 2004.

This paper was originally published while Dean was working for GHD Pty Ltd, Melbourne.

ALS Industrial
EXPERTISE INDEPENDENCE
Corrosion and Coating Failure Investigations
Fitness for Purpose and Remnant Life Assessment
Expert Witness and Litigation Support
Corrosion, Materials & Mechanical Engineers
Applied Scientists, Metallurgists, Coating Inspectors
NDT Technicians
Australia Wide
Arthur.Austin@alsglobal.com
+61 7 3718 0300
www.alsglobal.com
RIGHT SOLUTIONS RIGHT PARTNER

AMAC CORROSION
markrigg@amacgroup.com.au
ph - 03 9729 8888
JAS-ANZ

www.amacgroup.com.au
Corrosion Protection Materials
Design & Manufacture in Australia Since 1974

ANODE ENGINEERING
We are an independent supply and engineering house providing various industries with class leading products and engineering services. Please check our website for more information.
Head Office QLD
PO Box 4444
30 Chetwynd Street
Loganholme QLD 4129
Australia
Ph +61 7 3801 5521
1800 446 400
Servicing all states and territories, as well as New Zealand and South East Asia.
sales@anodeengineering.com
www.anodeengineering.com

DH Tech DeHumidification Technologies PTY LTD
David Dawson
National Sales &
Operations Manager
Director Australia
Phone: 1800-RENT-DH(736-834)
Mobile: 0450 008 259
Office: 02 9833 0777
Fax: 02 9833 0700
Email: ddawson@rentdh.com
www.rentdh.com
DeHumidification Technologies PTY LTD
6 Warrior Place St Marys NSW 2760 Australia

D R MAY Inspections
David May
Welding Supervision
Welding Inspection
NDT Specialist
Coating Inspection
Inservice Inspection
Geelong Office: 193 Station Street,
Corio, Victoria 3214 Australia
Postal Address: P.O. Box 1080,
Corio, Victoria 3214 Australia
Tel: +61 3 5275 3339
Fax: +61 3 5275 0585
Mob: 0412 520 699
Email: dmay@drmay.com.au

Duoguard
Specialist Suppliers of Cathodic Protection Systems
David Hadley MAusIMM.
Business Development Manager
Mob: 0419 632 241
david.hadley@duoguard.com.au
Duoguard Australia Pty Ltd
Unit 7, 7-9 Brough St
Springvale Vic 3171
Ph: 1300 782 501
Fax: 1300 782 503
www.duoguard.com.au

ICCC INTERPROVINCIAL CORROSION CONTROL CO. LTD.
Leaders in the Cathodic Protection Industry…Since 1957
SOLID-STATE CATHODIC ISOLATOR®
Mitigation Of AC Induced Voltages • Lightning • AC Fault Current
Intertek IEC IECEx
TEL: 905-634-7751
RUSTROL® SYSTEMS
FAX: 905-333-4313
www.Rustrol.com

INDUSTRIAL Minerals (NZ) Ltd
KURT RUSSELL
Sales Manager
Abrasive Blast Media Supplier
SUPER GARNET & GEO-BLASTER®
Exclusive Distributor for Australia & New Zealand
www.mineralscorp.com
sales@industrial-minerals.co.nz
AU Free Phone 1800 309 734
NZ Free Phone 0800 646 372

Infracorr Consulting PL.
Ian Godson – 0418 368 172
Infrastructure Repair Specialists
• Condition Assessment
• Durability Analysis
• Design & Specifications
• Cathodic Protection Solutions
• Hybrid Cathodic Protection
Ph – 1300 805 089
www.infracorr.com
Infracorr
Corrosion • Durability • Repair

ndt EQUIPMENT SALES
Leading Suppliers of NDT Equipment for the Corrosion Industry
Unit 23, 58 Box Rd Taren Point NSW 2229
Tel: 02 9524-0558 • Fax: 02 9524-0560
Email: ndt@ndt.com.au • Web: www.ndt.com.au

NZ INSPECTION RENTALS LTD
TECHNICAL RENTAL SPECIALISTS
Ron Berry
Toll Free: 0800 300 338
Mob: 021 990 550
E-mail: Ron@nzir.co.nz
www.nzir.co.nz
P.O. Box 6095
93B Mangorei Road
New Plymouth 4312
New Zealand
Servicing the corrosion & protective coating industries of NZ

Phillro INDUSTRIES P/L

Australasian Principal
Elcometer Service Centre
Victoria
New South Wales
Brisbane
Western Australia
Distributors all States
and Auckland N.Z.
Phone: 1300 503 610
Email: sales@phillro.com.au
www.phillro.com.au

SPA
Specialist Supplier of Corrosion Prevention Materials
SAVCOR PRODUCTS AUSTRALIA PTY LTD
Vinay Swaroop
General Manager
2 Macro Court
Rowville VIC 3178 AUSTRALIA
Phone: +61 3 9764 2651
Mobile: +61 423 783 614
vinay.swaroop@savcor.com.au
www.savcorproducts.com.au

tawfik
Impartial investigation and independent expert witness in:
- Forensic engineering (material failure, safety/accidents, fire)
- Compliance (metal fabrication, quality, fitness for purpose)
- Material characterisation(metallurgy/corrosion/welding/fatigue)

Dr David Tawfik — Principal Materials Engineer
BEng(Hons) BDes PhD MIEAust CPEng RPEQ
m +61 (0)4 1225 5112 e tawfikd@tawfikgroup.com.au
www.tawfikgroup.com.au

TRISTAR AUSTRALIA PTY LTD
Perth Branch
Tel: +61 8 9494 2151
Fax: +61 8 9434 9206
Brisbane Branch
Tel: +61 7 3208 0582
Fax: +61 7 3208 0094
Website: www.tristar-au.com Email: sales@tristar-au.com
• Manufacturer of **DIMET** Sacrificial Anodes. Design, survey, installation and commissioning of ICCP by NACE certified CP Engineers
• **MASTERCOTE PTFE** Coated and high grade alloy/ stainless/ high nickel/ super duplex special fasteners (e.g. anchor/stud/hex bolt).
• Zinc Film Galvanizing System.
A Division of TRI-STAR Industries (Singapore)
Website: www.tristar.com.sg Email: sales@tristar.com.sg
Tel: +65 6266 3636 Fax: +65 6265 3635 / 2801

CORROSION & MATERIALS

Advertising Rates 2015

(all prices include GST)

Deadlines
August – 10 July
October – 4 September
December – 23 October

Advert Size	Price per insertion Casual	3 issues	6 issues
Issue Sponsor Cover	$4,500.00		
Full Page*	$2,100.00	$1,800.00	$1,500.00
Back Cover	$1,500.00	$1,300.00	$1,200.00
Half page	$1,500.00	$1,300.00	$1,000.00
Third Page	$1,300.00	$900.00	$700.00
Quarter Page	$1,000.00	$800.00	$520.00
Business Card	$250.00	$175.00	$120.00

* All full page advertisements also include six issues of complimentary business card listings.

AvantGuard® Redefining anti-corrosion

Hempel introduces AvantGuard®, a new innovative anti-corrosion technology, based on activated zinc and locked into our new range of high performance protective coatings.

AvantGuard® reduces the effects of corrosion and offers advanced protection. This increased durability has been proven in extensive tests.

Redefining protection with reduced rust creep and enhanced corrosion protection

Redefining durability with improved mechanical strength

Redefining productivity with greater working tolerances in different climatic conditions and with high DFT's. Less repair work needed.

Redefine your expectations of anti-corrosion coatings with **AvantGuard®** by Hempel.

HEMPEL