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galvanize

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Asia Pacific Edition

HOT DIP GALVANIZED STEEL

THREE CONTRASTING PROJECTS, TWO CONSTANT THEMES – SUSTAINABILITY AND DURABILITY

In this issue

Welcome to galvanize 81 – this edition features three contrasting categories of construction using hot dip galvanized steel. The first article describes one of many similar major engineering projects underway in Melbourne over the last couple of years – the removal of a railway level crossing. This project is immense in scale, requiring around 2,200 tonnes of steel, much of it hot dip galvanized.

The second article profiles a small architectural practice in regional Western Australia and two of the houses they have completed in recent years. Each of these houses feature expressed hot dip galvanized steel and deliver a unique solution to a design problem. We've also included some ideas on how to solve the problems identified by the architect in a separate article, with size, appearance and design aspects of hot dip galvanizing that require an understanding of the process to deliver the best outcome.

The third article is from across the ditch, and the redesign of the Auckland Harbour Bridge lighting poles with an explanation of the challenges overcome when designing a structure for durability. This is an excellent example of thinking ahead, and building with the future in mind.

Each of the projects featured in this edition of galvanize have constant themes – those of sustainability and durability. We'll have more to say about sustainability of hot dip galvanizing in the next edition of galvanize. Watch this space! In the meantime, enjoy the current edition and if you want to know more about hot dip galvanizing, visit our website (**ww.gaa.com.au**) or contact us to deliver a free, tailored CPD on any aspect of HDG.

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Chief Executive Officer

galvanizers
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LEVEL CROSSING REMOVAL WINS 2018 GALVANIZED PROJECT OF THE YEAR AWARD

The Galvanizers Association of Australia (GAA) is pleased to announce that the 2018 Galvanized Project of the Year Award was won by the Level Crossing Removal Project (Carnegie, Clayton, Hughesdale, Murrumbeena and Noble Park), entered by van der Meer Consulting.

Presented in late December at the Australian Steel Institute's annual awards ceremony, the Galvanized Project of the Year Award recognises high standards of design, fabrication, construction and corrosion protection achieved when hot dip galvanizing features as a key component of a project.

The finalists included: Baldivis South Secondary School by Parry and Rosenthal Architects and BPA Engineering; Coopers Malting Facility by Ahrens Group; and Mars Stadium by Plinius Engineering.

Project Overview

The Level Crossing Removal Authority (LXRA) is removing 50 dangerous and congested level crossings across Melbourne.

The Caulfield to Dandenong package of works will see nine level crossings removed along the Caulfield to Pakenham rail corridor, as well as the upgrade of power and signaling. The $1.6 billion project also includes five new stations at Carnegie, Murrumbeena, Hughesdale, Clayton and Noble Park.

The innovative design featured in the package of works centres on three sections of modern elevated rail, which will create 22.5 hectares – the equivalent of 11 MCGs – of community open space. Together with the 65 new High-Capacity Metro Trains on order, the project will create room for 11,000 extra passengers to catch the train on Melbourne's busiest rail line.

Engineering Innovation

The project scope encompassed five main canopies (one for each of the new train stations) and 34 auxiliary buildings, which saw van der Meer Consulting undertake the detailed fabrication of over 2,200 tonnes of steel, and the processing of over 50,000 drawings.

The focus of each station was its main canopy, which took the form of an inverted horseshoe shape that was curved in both directions for a length of 100m and a width of 22m. Each canopy was then mounted on the train track viaducts.

The Use of Galvanizing

Both the architectural and engineering consultants specified a range of corrosion resistance systems for the main canopies at each of the five stations. van der Meer Consulting took into consideration corrosion resistance requirements before proceeding with galvanizing for the main canopies.

Galvanizing was selected for maximum corrosion resistance and long-term protection. It delivered a protective coating manufactured to last for the life of the canopies. In comparison, 'paint over steel' offered a shorter life span, which would have contributed to additional costs in scheduled maintenance to retain corrosion protection.

Over the course of approximately six months, GAA member GB Galvanizing Services undertook the galvanizing of all members for the five main canopies. According to Vince Gucciardo (Operations Manager, GB Galvanizing Service), "Galavanizing was a perfect solution for this project because everything was delivered on a 'just in time' construction schedule. We had the galvanized members on-site with 24 or 48 hours."

L to R: Peter Golding (CEO, Galvanizers Association of Australia), Brian Cardelli (Associate – Structural, van der Meer Consulting) and Andres Viveros (Project Manager Detailing, van der Meer Consulting) at the awards ceremony.

"The project was an interesting one to work on – it featured single sections that were quite long and unusually shaped. There were even some nodes that were three-dimensional short pieces that – given their unique shape – took some time to determine how to hang them on head-frames," said Gucciardo.

GB Galvanizing operates two of the most modern galvanizing facilities in Australia, located at Bayswater and Dandenong in Victoria. A workforce of over 200 employees, 24 hour operations and a fleet of 15 semi-trailers ensures that GB Galvanizing can service the galvanizing needs of both local and interstate customers with ease.

Structural Steel Detailing

At all times throughout the structural steel detailing process, van der Meer Consulting collaborated with the fabricators and design consultants to provide fabrication drawings and reports that ensured a smooth fabrication process and, in turn, seamless erection.

All disciplines collaborated in a central cloud-based BIM structure operating on Autodesk's GLUE360 platform.

Due to the complexity of some of the structures involved, van der Meer Consulting was provided with the architectural, engineering and fabrication models as a reference for use in 3D CAD modelling. These highly detailed, accurate and comprehensive 3D CAD models proved invaluable – they enabled the design consultants to efficiently review and give feedback to insure their design intent was carried through to the fabrication stage.

van der Meer Consulting was also commissioned to detail the temporary support structures for the main canopies. As the main canopies were constructed from pre-assembled modules off-site, they all required temporary propping. All propping locations were pre-determined to ensure that each module could be installed safely and successfully in the tight time-frames available to the site crews.

PROJECT TEAM

Architect: COX Architecture
Structural Engineer: Aurecon and WSP
Head Building Contractor: Lendlease and CPB Contractors
Steel Fabricator: GVP Fabrications and Best Fab
Steel Detailer: van der Meer Consulting
Galvanizer: GB Galvanizing Service

Various members for the main canopies of the five train stations undergo galvanizing.

PROTECTIVE PATINAS HELP PRESERVE BUSH WILDERNESS

Archterra is a small architectural practice in Margaret River, Western Australia. Led by Paul O'Reilly, Archterra aims to deliver honest, inspiring and environmentally sustainable homes and small to medium sized projects. Typically, their clients have a respect for the natural environment and a desire to create something individually unique. Environmental sustainability and low-maintenance materials, such as galvanized steel, feature heavily in Paul O'Reilly's designs, including two recent projects – Bush House and Wilderness House.

Bush House

Located in a clearing within marri and jarrah bushland, Bush House was designed by O'Reilly to capture the feeling of camping under a simple tarp.

"Bush House is actually my own home. I designed it and completed all the roofing, cladding, carpentry and finishing work myself. I just had trades in to complete the slab, rammed earth, steel framing electrical and plumbing works. Because it was my home, the project was driven a lot more by budget – we invested in the elements that were most important to us," said O'Reilly.

The house's simple rectangular plan is separated east-west into sleeping and living zones and delineated by a change in floor level and a grounding rammed earth wall that continues through the house into the outdoors.

Taking cues from Californian houses of the 1940s, 50s and 60s, the house's prefabricated galvanized steel frame enabled the main support structure to be erected in a day. Infill timber framing was subsequently erected by O'Reilly under the protection of a simple single roof plane. The galvanized steel framing is visible both internally and externally, with its mottled patina continuing to change as it ages.

Wilderness House

Located on a secluded bush block of marri, jarrah and banksia in Margaret River, Wilderness House provides views of the sunrise, and enables the owners of the house to see straight down into the native vegetation below.

"The elevation of Wilderness House was driven by the client's brief. They had an existing house on the site – a chalet at ground level that didn't afford them any views. So, with Wilderness House, they wanted a structure from which they could see out, right across the tree tops," said O'Reilly.

O'Reilly's design features an elevated platform with large areas of glass in the master bedroom and living areas that slide open, evoking the feeling of being perched upon an open platform amongst the treetops.

"It is a very simple, rectangular plan. We dropped the internal walls down from the ceiling, so there is continuity of space from one end of the house to the other. As Wilderness House is in quite a secluded area, there are no doors inside the home – not even on the toilet – this helps maintain the sense of openness throughout the structure," said O'Reilly.

An inclined entry ramp constructed from galvanized expanded metal enables views through to the landscape below. "The graded galvanized steel entry ramp was a nice industrial touch – something a bit different to the usual steps. It was inspired by the robust corten steel used by the WA Parks and Wildlife Service in the gangways around the West Australian national parks and gorges that the client frequents," said O'Reilly.

A Protective Patina

"In every place that I've designed, I've tended to use galvanized steel – rather than a zinc rich paint finish – for corrosion protection. The reason for this is that galvanizing is a definite process. The entire member is dipped and completely covered, rather than relying on a tradesman to apply a paint at a certain, specified thickness. This is particularly important in a small town like Margaret River, where I live and work; there just aren't as many skilled tradesmen as in the major capital cities. All of the galvanizing for my projects is done in Perth and then transported to Margaret River."

"Galvanizing offers such a wonderful natural metallic self-finish. It has a nice patina and three dimensionality to it, that develops further over the years. This patina is a beautiful feature in any house."

"I remember, when I was younger, looking at light poles, and seeing the camouflage-style pattern left by galvanizing, and thinking it was amazing. I'm sure that's why I have a leaning towards galvanizing today – it has a warm, early childhood memory attached to it."

"Plus, when I'm talking to clients I can emphasise its low-maintenance aspects – my clients don't have to worry about painting it in a few years' time. I like to incorporate materials that are self-finishing – that are permanent. This also speaks to the sustainability of galvanizing," said O'Reilly.

A Visible, Architectural Finish

According to O'Reilly, there are some challenges in utilising galvanizing as an architectural finish. "Galvanizing does have its idiosyncrasies. When working with some builders, it seems to be a real fight to maintain the quality of finish of the galvanizing, which is essential, given that it's not a finish that is painted over or incorporated into walls or can be touched-up."

"In the Bush House particularly, despite talking with the fabricator about what we were trying to achieve, all the beams were double-dipped due to the selected bath being too short for the beam length – placed in the bath one way and then turned around the other way – resulting in big splash marks. The entire supply chain needs to understand when galvanized steel is a visible, architectural finish, not a concealed finish and take due care with dipping, transportation, handling and installation," said O'Reilly.

O'Reilly believes that there needs to be more discussion throughout the industry as to the parameters and classification of the term 'architectural finish' as applied to galvanizing. In addition, client education from the outset of a project is essential.

"You have to convey to clients that galvanizing is a process, not an applied finish. There will be mottling and irregularity. The client needs to be happy with the fact that the finish will not necessarily be regular like a paint finish. It won't be a totally clean, consistent finish. This is what gives galvanizing its individuality. It is only when clients embrace the uniqueness of galvanizing, that they get the full value out of the finish," said O'Reilly.

Galvanizing offers such a wonderful natural metallic self-finish. It has a nice patina and three dimensionality to it, that develops further over the years. This patina is a beautiful feature in any house.

PROTECTIVE PATINAS HELP PRESERVE BUSH WILDERNESS *CONTINUED*

Environmental Sustainability

Environmental sustainability is integral to O'Reilly's designs. "I believe in getting the basics right, the passive measures – things like ensuring the orientation of a building will capture the winter sun and keep out the summer heat. Another key focus for me is ventilation. It is important to determine a building's natural breeze paths," said O'Reilly.

For instance, in the Bush House, passive measures included efficient cross flow ventilation to ensure summer cooling and properly calculated eave overhangs for optimum sun penetration in the winter months. These passive measures were teamed with active measures such as a 3kW ground mounted solar array, a solar hot water system and a worm farm blackwater filtration system for garden irrigation.

"Material selection is also a core component of environmentally sustainable design. I try to encourage clients to opt for finishes – like galvanizing – that is pre-finished and doesn't require regular maintenance," said O'Reilly.

The Wilderness House features durable, nil-maintenance external materials. These materials respond to the requirements of a bushfire attack level 29, whilst the insulated, dark pigmented concrete slab and calculated horizontal sun shading ensure passive heating is maximised during winter.

> Material selection is also a core component of environmentally sustainable design. I try to encourage clients to opt for finishes – like galvanizing – that is pre-finished and doesn't require regular maintenance.
>
> O'Reilly

CASE STUDY: AUCKLAND HARBOUR BRIDGE

Since the opening of the original truss bridge in 1959, and subsequent widening with the box girder extensions in 1969, the Auckland Harbour Bridge has been one of the most iconic and busiest bridge structures in New Zealand. It not only connects water, telecommunication, power and gas services; but also carries an average of 180,000 vehicles that travel over the bridge each day. This makes it one of the country's most vital infrastructure links not only between the North Shore suburbs and the rest of Auckland City, but between the Northland Region and the rest of New Zealand.

In 1998, Opus International Consultants Ltd (now WSP in New Zealand) partnered with Fulton Hogan and TBS Farnsworth to form Total Bridge Services (TBS), and since 2012 have been an integral part of the Auckland Harbour Bridge Alliance (AHBA), maintaining and managing the bridge.

One of the latest developments was the recently completed Lighting Upgrade and Installation, for which 118 new poles were designed by WSP, with the project delivered by the AHBA.

Lighting Upgrade and Installation

WSP led the way in the lighting design and replacement of more than 140 High Pressure Sodium (HPS) lamps with low energy Light-Emitting Diodes (LEDs).

For those involved, the project has been a massive undertaking. Andy Collins, (Technical Principal – Lighting Design, WSP), said there was a very real need for the upgrade, which involved multiple engineering disciplines.

"LEDs are more robust than the old luminaires, which themselves have been replaced a number of times over the decades. This solution encompasses the latest changes in lighting technology saving over 50% in energy consumption while maintaining the New Zealand Transport Agency's requirements," said Collins.

The use of LEDs has had an immediate impact, lowering maintenance and operational costs, and significantly reducing light pollution from the Bridge. Crucially, the new lights improve night time visibility for drivers and are more effective in the rain, making for a safer driving experience.

Designing for the next 50 years

The project grew in complexity when the fatigue issues associated with the ageing lighting poles were taken into account. Raed El Sarraf (Technical Principal – Materials and Corrosion, WSP), said the upgrade required the installation of new poles, as the original poles were reaching the end of fatigue life due to vibration from the bridge traffic and wind loading.

"Fatigue has been a concern for the past decade resulting in the annual inspections and monitoring to detect cracks at high stress locations on the poles for the past five years. All of which adds to the operating cost of the poles."

Tony Raper (Principal Design Engineer, WSP) who designed the new poles said "Real time measurements of the poles vibration were taken over a three month period, which were used to supplement the theoretical wind loading when designing the poles. Having said that, we weren't just designing for wind. The most active part of the bridge is the 220m navigation span, which is also 45m above the harbour. In addition to wind, we needed to allow for traffic loading, in addition to the 'twisting' of the box girders during service."

"All of this meant that there were multi-directional vibrations applied at different loads and points on the pole. That is why the size and thickness of the new poles are slightly larger than the old to resist these differing loads," said Raper.

CASE STUDY:
AUCKLAND HARBOUR BRIDGE *CONTINUED*

Material Selection and Hot Dip Galvanizing

According to El Sarraf, the new hot dip galvanized poles were designed to withstand the applied loadings and vibrations, while still combining the aesthetics of the original 1959 and 1969 poles. This ensured a visual continuation between the past and the future, while providing a low maintenance durable solution for the next 50 years.

"Steel was chosen for this project, mainly due to its strength, versatility, ease of fabrication of the bespoke aesthetics, and its known fatigue design. This made steel an ideal material for this project in comparison to other materials, whether aluminium, fibre reinforced polymers, or even concrete," said El Sarraf.

"Once steel was selected, the next question was how to protect the poles. The original 1969 poles are welded onto the pedestal, thereby requiring site repair and maintenance of the protective coating system; next to live traffic lanes. All of which adds significant costs to the operational maintenance cost of the poles."

"When designing the new poles, we had to consider how to protect and maintain them. This was achieved by specifying hot dip galvanizing and by bolting the poles onto a new welded flanged base connection onto the existing pedestals. The beauty of this connection is that we can easily and quickly remove a pole and replace it with a refurbished pole overnight."

"The plan is to replace the first number of poles with spare examples. The removed poles will then be re-galvanized and re-installed elsewhere on the bridge. This maintenance methodology provides a much more efficient and cost-effective solution than painting all the poles in-situ."

"Finally, when dealing with unsealed steel hollow sections, hot dip galvanizing is the only way to protect the poles. Galvanizing delivered longevity and was the most cost-effective choice," said El Sarraf.

Designing and Detailing for Durability

An important part of the design process was designing and detailing for durability. WSP undertook a 12 month study assessing the atmospheric corrosivity at different locations on the bridge. It was confirmed that some locations on the bridge were are in different atmospheric corrosivity categories, for example steelwork that is sheltered from the rain but exposed to the marine aerosol can be taken as being in a C5-M (Very high-marine) to AS/NZS 2312.2, while the light poles that are rain washed, were found to be in a C3 (Medium) corrosivity environment. As such, the expected time to first maintenance for the rain washed galvanized poles is 25+ years, if not 50 years. So, the next question was, what is the actual amount of zinc deposited on the newly galvanized poles?

According to El Sarraf, "Once the first pole was fabricated, it was directly sent to be galvanized. We wanted to check what thickness of galvanizing could be expected, as well as the standard of finish. We were concerned that, because the steel chemistry of the pole components were different, we weren't sure whether the galvanizing finish would be mottled, shiny, or matte. The main concern was that the freshly galvanized poles would be too shiny, resulting in reflective sun strike off the poles that may distract motorists."

"When the poles came out of the galvanizing bath, we were pleased with the final look. It had a relatively uniform matte finish, hence sun strike was a non-issue. Also the measured thickness of the galvanizing was up to three times the minimum specified in the Standards (such as AS/NZS 4680). Therefore, while we allowed for the poles to undergo maintenance in 25 years' time, in reality there is a high likelihood that the poles may meet the 50 years design life with minimal maintenance," said El Sarraf.

Planning for Success

Considerable up-front planning and clear communication lines was vital to the smooth implementation of this project. According to El Sarraf, "There was a lot of work completed before the poles were delivered to site, from confirming the correct material was ordered and supplied, through to the fabrication process itself and welding inspection; as once galvanized, the poles were directly delivered to site to meet the tight installation timeframe."

"For example, we worked with the galvanizers and followed our galvanizing 'bible', the Designing for Galvanizing resource published by the Galvanizers Association of Australia; to ensure that once the poles were double dipped in the bath, they emerged as expected with no surprises or issues."

"Once delivered, the pre-planned installation process, which required the removal of the old poles, preparing the pedestal for the installation of the new flanged base followed by the bolting on the new pole, was an example of clockwork efficiency and a testament to the hard work the AHBA team went above and beyond to ensure that the Auckland Harbour Bridge is lighting the way into the 21st century," said El Sarraf.

PROJECT TEAM

Client: NZ Transport Agency
Delivered by: Auckland Harbour Bridge Alliance
Construction Management: Total Bridge Services
Design Engineer: WSP
Steel Fabricator: Rivet – Fabrication by Design (New Plymouth)
Hot Dip Galvanizer: CSP Coating Systems (Auckland Branch)
Luminaires: AEC Italy via TechLight New Zealand

HOT DIP GALVANIZING IN ARCHITECTURAL APPLICATIONS

Hot dip galvanizing (HDG) is an environmentally sustainable and low maintenance coating that is often utilized in architectural applications as an expressed finish.

Unlike paint coatings, hot dip galvanizing is a process, rather than an applied finish. As such, just like timber and other natural products, there will sometimes be visible mottling and irregularities on the surface. The finish will not necessarily have the consistency of an applied paint finish. In fact, the finish will slowly change over time as a patina is formed on the zinc surface. This is what gives hot dip galvanizing its character and individuality.

In architectural applications where optimum consistency of appearance is required, communication along the supply chain is key. The entire supply chain, from designer to builder, must understand when HDG structural steel is to be used as an expressed finish, and take due care throughout the dipping, transportation, handling and installation processes.

Most importantly, venting and draining is critical to safety. Expansion of trapped gases or liquids in sealed hollow sections can result in explosions in the HDG bath.

Steelwork Design

Steelwork must be designed with the HDG process in mind. The design of fabricated articles plays a major part in the final appearance of the HDG coating.

Fabricated items must be designed to enable adequate venting and draining. The HDG process involves dipping the item into a series of liquid-containing baths, including degreasing, pickling and fluxing solutions, as well as molten zinc.

At each stage of the HDG process, liquid must be able to readily flow over, and come into contact with, all surfaces of the submerged item. If air pockets exist in the fabrication, areas of steel may not be properly cleaned, fluxed, or wet by zinc, resulting in uncoated areas.

Good venting and draining design ensures that liquid can readily drain from the item when it is withdrawn from the bath, minimising run marks and trapped zinc. Flux is released from the steel surface after dipping into the HDG bath – so good venting and draining design ensures that ash and flux residues are not trapped on the galvanized surface as the item is removed from the molten zinc bath.

Most importantly, venting and draining is critical to safety. Expansion of trapped gases or liquids in sealed hollow sections can result in explosions in the HDG bath. Galvanizers will always confirm that the item to be galvanized has adequate venting and draining. If an item does not possess adequate venting and draining, the galvanizer will drill additional holes if necessary, but it is always better to consider venting and draining at the design stage. The GAA has developed a design guide for these aspects, which is available from our website or any GAA member.

Arts West Centre (ARM, in partnership with Architectus. Photo: Warick Baker). Winner 2018 Global Galvanizing Award (Industry Category)

Austin Hospital Car Park, Melbourne

Duplex railing

HOT DIP GALVANIZING IN ARCHITECTURAL APPLICATIONS *CONTINUED*

Double Dipping

Size does matter! If the object is too long to fit into the HDG bath it may have to be galvanized by utilizing the double dip method, in which case each end of the item is dipped independently into the bath (See the usual 3 steps in the photos following). The resulting coating has an overlap of coatings from the two dips and surface marks which are unavoidable – although the corrosion protection is not compromised.

The Finish: Spangled, Shiny or Dull, Rough or Smooth

When it comes to the finish of a galvanized item, there are many potential variations that have no effect on corrosion protection. Many galvanized coatings is affected by a characteristic 'spangled' appearance – a repeated triangular or flower-like pattern in different shades of grey. The size of this pattern is affected by variables such as the cooling rate, bath chemistry and steel chemistry. Other commonly seen variations in appearance occur due to the steel chemistry or surface condition of the steel. These factors influence the reaction between the zinc and steel which occurs while the part is submerged in the molten zinc, changing the coating's structure and potentially forming shiny, dull, rough or smooth coatings.

Material selection is a core component of environmentally sustainable design. HDG is an attractive, highly durable, pre-finished coating that doesn't require regular maintenance.

The highly durable nature of HDG also translates into a reduction in global resource usage. In fact, galvanized steel is the ultimate facilitator for the re-use of steel products and structures – zinc oxide is collected as a by-product of the steel recycling process, allowing the galvanized coating to be fully recycled along with the steel.

Duplex Coatings

Widely adopted, covered in AS/NZS 2312.2 and recommended by specifiers around the world, paint over hot dip galvanizing; known as a duplex coating offers designers the option of superior corrosion protection with the benefit of colour. Often used in corrosive locations, such as near the beachfront, abrasive sites or in areas where access to maintenance is limited, the duplex coating provides confidence that the design will remain attractive for many years to come.

Engineered systems are available for a range of applications; from simple decorative coats to 3-coat protective systems with a history of performance in the harshest of applications.

Designers can obtain free technical information on design aspects from our Technical Publications here or by contacting the GAA via email (**gaa@gaa.com.au**) or phone (**03 9654 1266**).

Island Wave, duplex sculpture by Lisa Young.

Lavarack Army Barracks (photo Christopher Frederick Jones).

Three stages of a double dip are: (1) one part of the article is dipped,

(2) the article is turned around and the second half is dipped,

Widely adopted, covered in AS/NZS 2312.2 and recommended by specifiers around the world, paint over hot dip galvanizing; known as a duplex coating offers designers the option of superior corrosion protection with the benefit of colour.

Vent holes can be drilled or cropped to allow the zinc to drain from the inside of hollow sections
The best venting for hollow sections for quality will allow the zinc to freely flow through the article.

(3) the completed article showing slight marking at the intersection of the dips, which will fade in time.

GALVANIZE MAGAZINE

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You can also view the current issue and back copies at the Case Studies tab on our website **www.gaa.com.au**.

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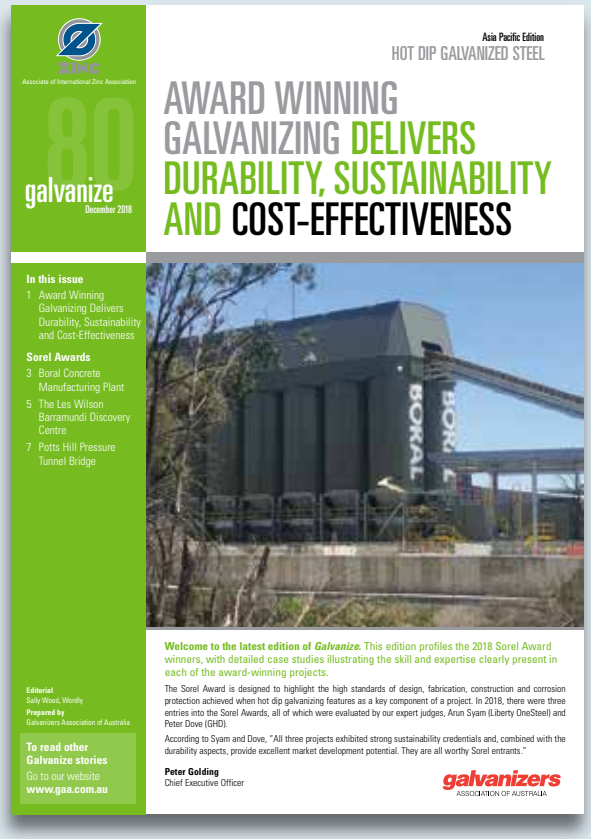

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We provide information, publications and assistance on all aspects of design, performance and applications of hot dip galvanizing.
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