HOT DIP Galvanizing TODAY 61
Hot Dip Galvanizers Association Southern Africa 2015 Volume 12 Issue 2

FEATURE ARTICLES

Intergalva 2015 – Winners and Submissions

Corrosion due to incorrect selection of materials

White rust and wet storage stains

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HOT DIP Galvanizing TODAY 61
Hot Dip Galvanizers Association Southern Africa 2015 Volume 12 Issue 2
Official journal of the Hot Dip Galvanizers Association Southern Africa
ISSN 1023/781X

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

PUBLISHED BY:
Hot Dip Galvanizers Association Southern Africa
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Reproduction and Printing: Camera Press Tel: 011 334 3815 Fax: 011 334 3912 Email: cpress@iafrica.com

Executive Director's Comment

As we draw to the end of our financial year, ended June 2015, we can reflect on the past 12 months. It has been a year of continuing change in that our attempts to find a suitable candidate to replace me as the Executive Director has finally been resolved with Robin Clarke joining the Association. I am most optimistic with regards to the future of the Association under Robin's leadership.

It was also a year in which the Association embarked upon a number of cost savings that included relocation of our offices to smaller premises and again centralising our base of operations to Bedfordview.

Due to current economics and market concerns we were again unable to hold our formal awards dinner, which would usually be the main feature of our magazine at this time of year. We have therefore chosen to substitute and report on the Intergalva 2015 Global Awards that includes submissions from countries around the hot dip galvanizing world.

Intergalva 2015 was successfully held in Liverpool UK during the first week of June with a large contingent of South African members in attendance. The Intergalva conference and plant visits are held every three years under the auspices of the European General Galvanizers Association. It is an occasion for world hot dip galvanizers and supporters to network and obtain updates on the latest research and developments taking place within the industry.

Looking forward to the next financial year, we remain concerned with the current business climate with particular emphasis with regards to the steel industry. Performance within the steel industry has a knock-on effect to steel fabricators and in turn to that of our galvanizers.

As a country we are facing a cocktail of cheap imports, falling value of the Rand, unemployment, demands by labour for higher wages, the lack of skilled and competent people, a mining industry under pressure and a NDP that does not appear to be receiving serious attention towards being fully implemented. Under such conditions it becomes even more important for any industry to maintain service standards and the delivery of quality products.

Bob Wilmot

Hot dip galvanizing training for inspectors

During June and July the Association presented a further two three-day Inspectors' courses, one at our Bedfordview offices and one in Cape Town. All participants passed with five candidates achieving over 75%.

Unfortunately on the Cape Town course, after all arrangements and bookings had been completed, four eleventh hour cancellations were received. As a result only three people attended the Cape Town course, which nevertheless proved to be most interesting due to the interaction of the participants.

We remain available to run the inspectors course anywhere in the country providing we have six or more candidates. It is also advisable that a hot dip galvanizing plant is available in the area to conduct the practical phases of the course.

Course No. 3 – June 2015.

Cape Town Course No. 4 – July 2015.

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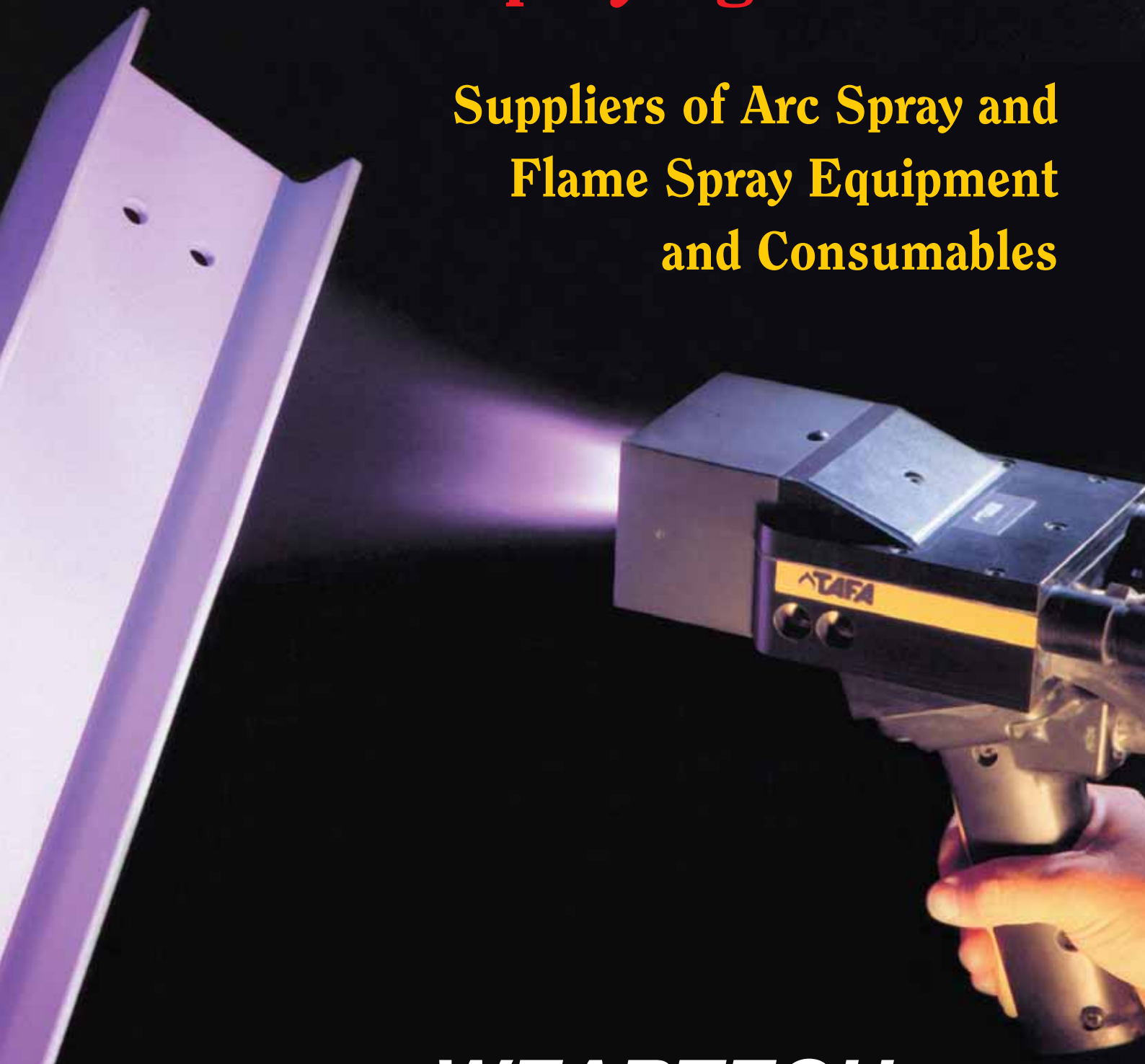

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Intergalva 2015: The Global Galvanizing Awards

Winners and highly commended submissions

The Global Galvanizing Awards, which were part of Intergalva 2015 recognise the innovative use of galvanized steel by architects, engineers and steel constructors. Forty five projects were entered through the national and regional galvanizers' associations across the world. The projects were reviewed in two separate judging processes:

Judges Award: comprising a panel from the world of architecture and design.

Industrial Award: a result of voting by the global galvanizing industry through the participating associations.

Highly Commended: In addition to the two main awards, a further four submissions were recognised with certificates presented under this heading.

Of all the submissions received from the country associations, one project was shortlisted and included as part of the awards presentation.

Projects were evaluated for their effective and innovative use of galvanizing in architecture and civil engineering, as well as the functionality and aesthetics of the structure. Special attention was also given to demonstration of the contribution of galvanizing to sustainable construction. The entrant's approach towards galvanizing and its incorporation in the design stages was also considered important.

Judges' Award Winner: Central Bus Station, Haldensleben, Germany

Photos: ©Schulitz Architects

The **Judges' Award Winner** was the new central bus station in the German town of Haldensleben. The station gracefully fills the void that gives shape to what had until recently been an abandoned site in front of the main railway station.

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A clever additional touch has been provided by semi enclosed seating areas that offer some privacy. The structure is extremely light and economical with hot dip galvanized steel being the predominant material, ensuring a long service life and making a significant contribution to ease of construction. The entire structure was pre-fabricated and easily erected on site.

The internal enclosure space has been landscaped to become a popular gathering space not only for commuters but also for local residents.

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Industrial Award Winner: Vienna Railway Station, Austria

The **Industrial Award Winner** was the dramatic lozenge roof of the new Vienna Railway Station in Austria. The railway station is the central hub in the trans-Europe rail network serving 145 000 people every day with over 1 000 trains passing through to destinations across Europe.

The station's spectacular steel and glass lozenge roof, 200 metres long and 120 metres wide, has become a symbol of modern mobility and functionality, and distinguishes the building from everything around it. The roof structure is made up of 14 individual diamond shaped modules, arching over five platforms. Its height varies between 6 and 15 metres so that it appears to hover over the platforms.

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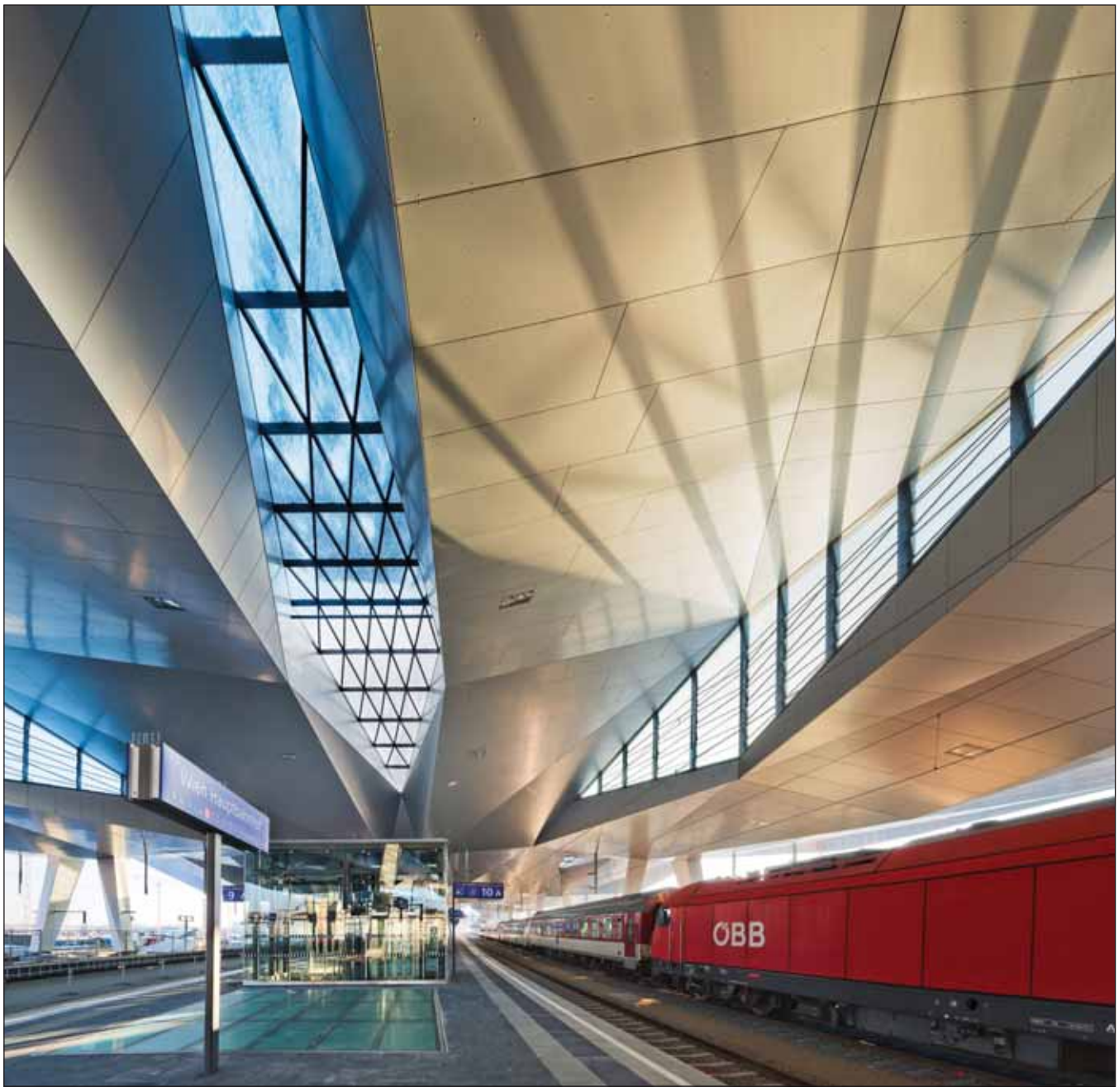

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Photo: ©Renée Del Missier, Unger Steel Group

Photo: ©Renée Del Missier, Unger Steel Group

The creation of the gigantic structure was a demanding challenge for the contractors and the steel construction company, not only from a technical point of view, but also with regard to the logistics of the project.

The complexity of the roof structure meant that it would be virtually impossible to maintain, so the design allowed for individual members to be hot dip galvanized and bolted together to form the complex rhombus for each section of the roof.

Hot dip galvanizing made it possible to avoid costly maintenance work that would entail closure of a busy railway station.

Highly Commended Submissions

Health Centre, Móstoles, Spain

The Social Care and Health Centre in the city of Móstoles (Southern Madrid) has been designed with two crucial design considerations; the creation of a multipurpose space on a very restricted budget. The four-storey structure creates more than 2 350m² of space incorporating 51 offices. Minimising the cost of maintenance of the entire building was a major consideration for the extensive use of hot dip galvanized steel.

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Water Tank, Guijo de Coria, Spain

In the rural wilderness of Western Spain, a new water storage tank structure dominates the skyline. From a distance it seems to mimic the form of a transmission tower and on closer inspection that initial response is justified.

The primary objective of the designers was to develop a clear form with a minimal footprint. The new water tower is defined by a network of galvanized steel in the form of a stretched lattice cross. A platform at the top holds two 40m^3 stainless steel tanks. Timber has been used to form the stairs and platform necessary for the maintenance of the water tower.

The provision of 80m^3 of capacity at a height of 22m could so easily have resulted in a structure that was both massive in volume and footprint. The solution of using a lattice frame has resulted in an elegant structure that not only has a light touch but at the same time demands attention.

Sugar Warehouse, Santos, Brazil

The new Sugar Warehouse with a storage capacity of 80 000 tons is located in the sugar terminal of Rumo Logistica in the port of Santos. Measuring 200m x 40m and a height of 30m it is considered to be one of the largest of such facilities within the terminal. The galvanized steel trusses have been designed to follow the angle of repose of the mounds of sugar stored within.

The engineers chose hot dip galvanizing to ensure they could deliver the building on time and with favourable economics during construction. A commitment was to galvanizing at the first design stage and demonstrated that even large structures can be galvanized if component sizes are matched to the available zinc kettle sizes.

The whole structure was hot dip galvanized, including the structural fasteners.

Cliffwalk, Capilano Suspension Bridge Park, Canada

The Cliff way's cliff-side location makes it difficult to maintain and repair, as the arc hangs 295 feet above the river below. Furthermore, the location is only a few miles from the Pacific coastline that surrounds Vancouver, allowing constant contact of corrosive moisture with the exposed steel elements. A maintenance free corrosion control system was critical to avoid the dangerous, costly and unpleasant task of routine maintenance. The superior barrier protection of hot dip galvanized steel made it an ideal choice for corrosion control of the new facility.

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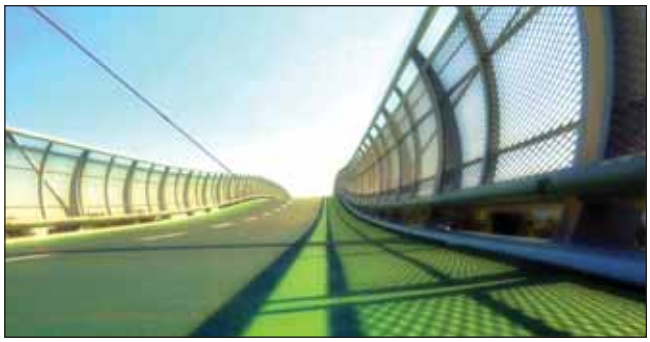
Shortlisted country submissions

Bicycle Bridge of Liberty – Slovakia

Photos from Czech and Slovak Galvanizers Association

A fully hot dip galvanized finished sweeping steel structure, the 525m x 4m wide bridge between Schlosshof in Austria and Devínska Nová Ves in Slovakia establishes an old link that was lost during the cold war.



Courchevel Aquatic Centre – France

Photos: ©B+G Ingenierie, Bollinger+Grohmann SARL

A 120m x 80m hot dip galvanized structural steel double curved roof structure emerges from the ground and covers the whole area on a minimum number of supports.

Garsington Opera Pavilion Buckinghamshire – United Kingdom

Photos: (below left) by ©Mike Hoban; (below right) by ©Dennis Gilbert

The entire steel structure was pre-fabricated and hot dip galvanized, providing a maintenance free, durable and corrosion resistant protective finish. As the building is modular and entirely demountable it is an extremely flexible structure that can be adjusted as required to suit the changing opera performance.

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Geophyte Research Station Yalova – Turkey

Photos: ©Genel Galvanizciler Derneği GALDER

The entire project covering 20 000 m² uses hot dip galvanized structural steel because it gave the required flexibility of design and ease of construction. When it came to protection against corrosion, the architect explained his choice as follows:

"We preferred to use hot dip galvanized coatings as it is the most environment-friendly corrosion protection solution to make the Geophyte Garden long lasting".

Ilico Apartments Auckland – New Zealand

Photos: ©Perry Metal Protection Limited

The architects described Ilico as consisting of 65 one and two bedroom apartments over five levels, developed for purchasers with limited budget in the newly established suburb of Stonefield.

The final corrosion control system comprised hot dip galvanizing and painting, required to meet both corrosion control and aesthetic client requirements.

Pedestrian Bridge, Hradec Králové – Czech Republic

Photos: baum & baroš, Aachen

The design incorporates a truss with an under-stressed structure, derived from a Polonceau girder, with the upper beam forming the deck, divided into two articulated sections. A tensioned cable in the form of a five sided polygon creates the bottom cord of the truss. The transfer of loads is aided by the incorporation of three compressively stressed elements between the deck structure and the tensioned chord.

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Troll Office Building Stavanger – Norway

Photos: ©Norbert Miguletz

A compact building structure, excellent U-values, low filtration facades and balanced ventilation has helped to achieve the robust passive and Energy Class A standards. The façades of the building consists of galvanized panels 4.5m x 0.4m x 1.6mm. The total volume of the façade is 3 300m². Hot dip galvanizing was chosen for its sustainability credentials in comparison to other materials.

Scenic World, Katoomba – Australia

Photos: ©Brett Boardman

The Scenic Railway Katoomba redevelopment is a world-class tourist attraction, located in the Blue Mountains of NSW Australia

Hot dip galvanizing steelwork was integrated into all facets of the project. This included new loading and unloading platforms and stairs for top and bottom stations, service walkways, bottom station towers, equipment platforms and a balcony extension.

Park + Ride Open Air Car Park, Elst – Netherlands

Photos: ©M. Stammers & I. Velner

Located beside the railway line connecting Nijmegen and Arnhem, Elst's new park and ride open air car park accommodates 590 vehicles.

The modular car park consists of hot dip galvanized steel with slender box columns and IPE beams with a composite deck.

Waste-to-energy Plant, Bolzano Sud – Italy

Photos: ©Oskar Da Riz / Stahlbau Pichler ; CLEAA

The new plant consists of two huge units which run alongside the motorway on one side and the Isarco River on the other. The energy produced by the plant will used for the heating of domestic hot water needs of 8 000 inhabitants. It will also reduce carbon dioxide emissions equal to 80 000 tonnes a year.

Kirstenbosch Treetop Walkway – South Africa

Photos from Hot Dip Galvanizers Association of Southern Africa

The Centenary Tree Canopy Walkway is a curved steel and timber bridge that winds and dips its way through and over the trees of the Arboretum. The walkway is 130m long, narrow and slender, with a few wide viewing areas and snakes its way through the canopy in a discreet and almost invisible way

The main spine of the walkway is constructed from hot dip galvanized tubular steel frame, with welded ribs and a light mesh to cross brace and allow the structure to act as a bridge-spanning beam.

ACKNOWLEDGEMENTS

The following galvanizing industry associations have made the 2015 Global Galvanizing Awards possible:

- American Galvanizers Association
- Asociación Técnica Española de Galvanización
- Associazione Italiana Zincatura
- Czech and Slovak Galvanizers Association
- European General Galvanizers Association
- GALDER Galvanizers Association
- Galvanizers Association of Australia
- Galvanizers Association of New Zealand
- Galvazinc Association
- Hot Dip Galvanizers Association Southern Africa
- ICZ – Instituto de Metais Não Ferrosos
- Industrieverband Feuerverzinken eV
- Nordic Galvanizers
- Zinc Info Benelux

Report on Intergalva 2015

Cunard Line head offices, Liverpool.

Royal Liver Building, Liverpool.

Intergalva, the conference and trade exhibition organized by the European General Galvanizers Association, has been held every three years since 1950. This year's event took place in Liverpool in the United Kingdom, from 7 – 12 June.

The conference covers technical, commercial and environmental topics of strategic importance to the hot dip galvanizing industry.

The dockland city of Liverpool has a rich history ranging from being the home port of the Lusitannia, to the place from which the iconic pop band the Beatles started. It's also home to the world famous Liverpool football team. Regeneration programs have transformed the dockland area into a warm and vibrant place with the Albert Dock, the Cunard Line head offices and the Royal Liver Building all forming wonderful backdrops to the conference venue.

Association members gathered on Sunday to discuss matters of mutual interest. In summary the topics covered were

1. Life Test information – an update on empirical data collected. The interesting conclusion reached was that in areas now generating cleaner energy (lower SO^2 emissions), corrosion rates are reducing. This could have an impact on revisions to ISO 9223: 2012.
2. The global galvanizing awards procedure was discussed, the main theme being a way to recognize both engineering excellence and aesthetic or architectural appeal.
3. Hydrogen embrittlement was discussed in the context of tests being performed by Tom Langill of the American Galvanizers Association. Interim findings raised issues about the

The overall winner (above left and right): Vienna Railway Station, Austria.

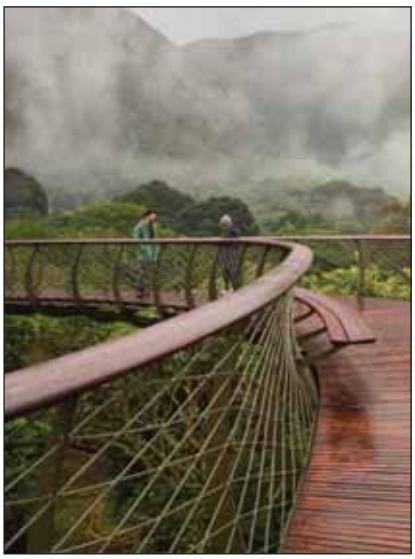
influences of alloying elements in the steels versus the assumption that the presence of hydrogen being the determinant factor in failures of high tensile fasteners.

4. The association representatives discussed training needs for the industry and in particular training material for inspectors. It was a proud moment when the South African course was considered by many to be the standard against which they were benchmarking.
5. The meeting concluded with a short presentation by the Indonesian delegation. Staggering expenditure for infrastructural development is being planned for that part of the world. As an example, 15 airports and 24 seaports are to be built or redeveloped over the next four years.

An opening function for the conference was held at the Pan Am club on the Sunday evening. This presented all the delegates with an ideal opportunity to interact on an informal and social level. Old acquaintances were renewed and new introductions made against the backdrop of the Beatles cover band entertaining the delegates with musical hits from the 1960s.

Formal proceedings started on Monday June 8 and a thought-provoking key note speech was delivered by Lord Digby Jones. The central theme of the address was the absolute need for a healthy and vibrant manufacturing and construction sector for a sustainable economy. Production of goods creates employment and strategic enablers are necessary to encourage such industry.

Inside the auditorium a program of lectures and presentation of research papers was well attended with delegates cherry picking topics of interest to themselves. In conjunction with these lectures, informal and interactive workshops were in full swing in the exhibition hall. The exhibition hall was filled with display stands showing delegates all manner of products and services which support the industry.



One of South Africa's submissions was the walkway in Kirstenbosch Gardens, Cape Town.

The conference Gala Dinner was held on the Tuesday evening in the Liverpool Anglican Cathedral. Over and above a wonderful meal in an awe inspiring setting, the delegates were entertained by a capella group and later that evening by tenor Jon Christos and soprano Danielle

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Thomas singing some well-known show songs. Of personal interest were the many memorial plaques for the individuals from the parish who succumbed during various armed conflicts, including battles in faraway South Africa.

As the conference drew to its conclusion on Wednesday the Global Galvanizing Awards were announced. Each national association was given an opportunity to rate the submissions in advance of Intergalva. It was furthermore decided that the competition would recognize technical excellence and architectural appeal separately. From these rankings awards were made for Highly Commended projects as well as an overall winner chosen.

The overall winner was the Austrian submission for the main railway station in Vienna, with over 7 000 tons of galvanized steel forming an unusual but very appealing roof structure.

The Kirstenbosch Treetop Walkway, a submission from South Africa, was shortlisted.

Although formal conference proceedings were concluded on the Wednesday, tours had been arranged to view galvanizing plants. Our tour of choice meant a bus trip from Liverpool into the Birmingham/ Walsall area and yes the traffic was a challenge. The leisurely trip however created yet another opportunity to interact informally with operators and suppliers to the industry. On arrival we were graciously hosted by both the Joseph Ash and Wedge Groups at their plants in and around this area. Plant layouts, production planning and control systems, process and environmental control systems were all openly shared and discussed.

Meeting with the leadership of our allied associations and suppliers, absorbing the latest thinking in hot dip galvanizing as presented by the conference papers, and attending workshops meant that, by any measure the trip to Liverpool was a resounding success.

Robin Clarke, Technical Director, Hot Dip Galvanizers Association Southern Africa

Corrosion due to incorrect selection of materials

Based on numerous field investigations, a common finding as to early corrosion failures can be traced to the incorrect selection of the materials of construction.

Corrosion is defined as an electro-chemical process, due to the fact that both chemical reactions that take place resulting in electron flow.

Technical terms associated with such a process and corresponding accelerated corrosion cells is called "galvanic corrosion" due to a "by-metallic couple" of two different materials. In order to create such a corrosion cell four elements must be present, being two different materials, an electrical circuit and an electrolyte such as an atmosphere, soil or water environment.

A positive outcome

The physics of a by-metallic couple is utilised when carbon steel is hot dip galvanized (HDG), i.e. a zinc based coating.

A by-metallic couple is created when a zinc coating (HDG), being electro-negative to carbon steel, is electrically connected to electro-positive carbon steel. The zinc coating will sacrifice itself, as the anode, to protect the carbon steel cathode. This is referred to as "sacrificial protection" or more commonly known as "cathodic protection".

Hot dip galvanizing has two systems of corrosion control, being that of a "barrier protection" and when required a second line of defence "cathodic protection". The first line of defence is a "barrier protection", being the result of zinc reacting with its environment to create a zinc carbonate layer that has a matt grey surface finish. Sometimes this process is referred to as zinc "weathering".

Corrosion due to a by-metallic couple

The development of "galvanic corrosion" as a "by-metallic couple" can be directly related to the poor selection of materials of construction and that will result in a reduction of service life of an installation. The following examples have been taken from actual site investigations and are illustrations of poor material selection.

Sluice gate

The first example relates to a hot dip galvanized large carbon steel sluice gate that was fabricated in two sections and bolted together using stainless steel fasteners. The engineer recognized the potential for galvanic corrosion and therefore specified nylon insulating washers

Sluice Gate: Two different materials being stainless steel fasteners (cathode) and zinc (anode), in electrical contact in the presence of water (electrolyte), the zinc will be sacrificed to protect the stainless steel.

under the bolts and nuts. This was done in order to break the electrical connection and thus avoid a by-metallic couple.

Unfortunately, in all instances with one exception, the stainless steel made electrical contact on the inside of the bolt holes and an electric circuit was completed. The result was that the electro-negative zinc (anode) sacrificed itself in order to protect the electro-positive stainless steel (cathode) fasteners. In the single case where no electrical connection was made on the inside of the bolt hole, no corrosion was present. The fact that the stainless fastener had not made an electrical contact on the inside of the bolt hole was purely fortuitous.

Corrective actions would be to replace the stainless steel fasteners with hot dip galvanized nuts, bolts and washers.

Handrailing

This example is of a hot dip galvanized fabricated carbon steel stanchion, to which a stainless steel foot rail and handrails have been attached and making an electrical connection. The combination of these elements together with the Kwazulu Natal marine atmospheric environment completes the four requirements for a by-metallic couple. Given time the zinc (anode) will sacrifice itself to protect the stainless steel (cathode) foot and hand railings. Such a result could cause questions to be asked as to the role of hot dip galvanizing as a means of providing corrosion control.

Handrailing: Hot dip galvanized stanchion with stainless steel foot and hand rails in contact with each other. This is a recipe for galvanic corrosion.

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Corrosion control of this installation rests with the design and the poor selection of the materials for the installation.

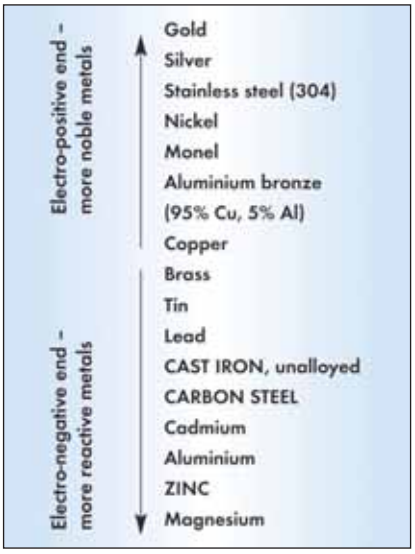
Corrective actions would be to insulate or replace the stainless steel with hot dip galvanizing or alternatively use stainless steel throughout the installation.

Plumbing (gents urinal)

The last example reviews a typically encountered plumbing problem.

A maintenance situation in which a hot dip galvanized water pipe requires replacement due to its contact with a stainless steel urinal. The plumber resorts to the use of copper, brass fittings, and hot dip galvanized carbon steel; all in contact with the stainless steel urinal. The result is clearly evident in the following photograph in which the hot dip galvanized connecting carbon steel pipe between the copper/brass fitting and the stainless steel has corroded to a point where virtually no zinc remains and the carbon steel is corroding. The zinc coating has sacrificed itself to protect the stainless steel, brass fitting and the copper pipe. Once the carbon steel has been exposed it will corrode in preference to the electro-positive stainless, brass and copper fittings.

What not to do in plumbing: An illustration of a combination of different metals within a single installation that will lead to corrosion and an unacceptable service life. Materials used: hot dip galvanized carbon steel; brass; copper; stainless steel.



Galvanic series of metals: Electrochemical potential scale in sea water at 25°C. Zinc is electro-negative to carbon steel and cast iron.

Conclusion

In order to avoid such corrosion problems and obtain an acceptable service life of any installation, the designer should have a working knowledge of by-metallic couples, galvanic corrosion and what constitutes a corrosion cell. Specify the same materials of construction and where this is unavoidable; dissimilar materials must be electrically insulated from each other.

For a greater understanding of these examples, reference should be made to the "Galvanic Series of Metals" or discuss the subject with us at the Association.

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White rust and wet storage stains

Photo 1: Closely packed hot dip galvanized straps stored with water trapped within the bundles.

Photos 2 – 3: Removing the top strap from the stacked bundles of re-enforcing straps, the extent of the wet storage stain becomes evident. It is important to understand that the longer the trapped moisture is allowed to remain the more the zinc will be consumed.

There are two possible forms of white rust. Firstly the less problematic form where newly hot dip galvanized steel, exposed to atmospheric moisture, reacts rapidly to form a white surface deposit of zinc oxide (ZnO) and zinc hydroxide $Zn(OH)_2$, both of which combine to constitute a white powdery deposit known as **White Rust.**

Hot dip galvanizers provide limited protection against this form of white rust by a passivation process that follows immediately after the material exits the molten zinc kettle. The passivation solution gives the hot dip galvanized surface a yellowish tinge that does not affect corrosion control of the coated steel.

A more serious development of white rust, ZnO and $Zn(OH)_2$ is when zinc coated steel is stored with moisture trapped between closely packed components *(photo 1)*. White rust, in the form of wet storage stain will continue unabated as long as the micro-climate created between the stacked materials is allowed to exist and until such time as the zinc coated surfaces are separated *(photo 2 and 3)*. This is a more insidious form of white rust, referred to as **Wet Storage Stain.**

Wet storage stain case study

In December 2011 the Association was requested to attend a site meeting due to a quality complaint relating to severe white rust. *Photo 4* clearly illustrates the client's genuine concern.

However, the photograph also shows four tank plates, comprising the assembly structure, where no white rust is evident. From this it can be concluded that the white rust is a result of the plates being stored with moisture trapped between causing wet storage stains. Three plates without white

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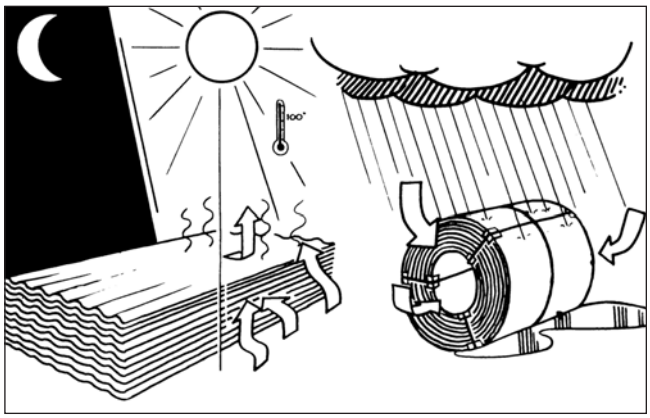
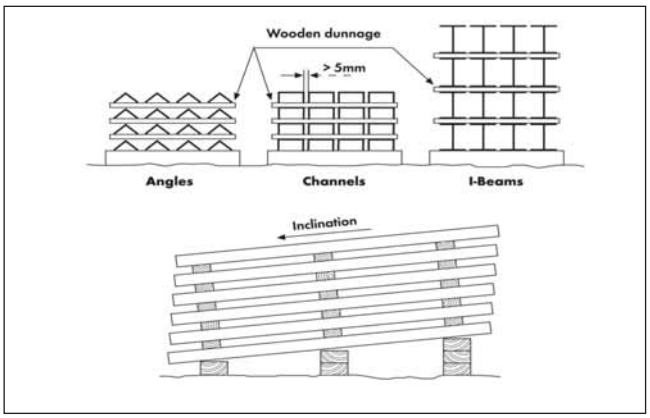
Photo 4: December 2011: An example of wet storage stains. Note the absence of white rust on certain plates, three with fittings that were not part of the packed materials and one plate from the top of a bundle (circled in orange). The plates were white rusted before assembly due to wet storage stains.

Photo 5: May 2015: The same tank after 3 years and 5 months in service. The surface colour is becoming more and more uniform as the zinc is allowed to weather and develop its protective barrier of zinc carbonate providing corrosion control.



Sketch 1 shows how NOT to store zinc coated steel. Wet storage stain is inevitable when stored in similar conditions.



Sketch 2 is a representation of recommended site storage in order to prevent wet storage stains. Allows for drainage as well as limited zinc on zinc contact.

rust all have attached fittings and would not be stored as part of a bundle. In the case of one plate, top left, again without any sign of white rust, this came from the top of a bundle.

Using this project as a case study, routine visits have been undertaken, from December 2011, in order to monitor how the white rusted surfaces weather over time *(photo 5)*.

White rust is very unstable and will, given time, wash off revealing a matt grey surface colour. It is from this process that the word "stain" is derived in the term Wet Storage Stain.

Conclusion

When hot dip galvanized material is to be stored, it must be under cover (dry) or in a situation so as to allow full air circulation to all zinc surfaces.

The following examples are suggested methods of how wet storage stains can be prevented.

Photo 6 is an example of how hot dip galvanized air cooled condensers were stored on site, exposed to a wet and dry atmosphere, for upwards of 12 months. No wet storage stains were encountered.

Sketches 1 and 2 depict examples of how hot dip galvanized material should be stored after processing as well as on the construction site.

Further information on white rust and wet storage stains can be obtained for the Association website www.hdgasa.org.za, under Technical Information Sheet No 2.

Photo 6: Storage to avoid wet storage stains. Fully ventilated as well as protected from ground moisture.

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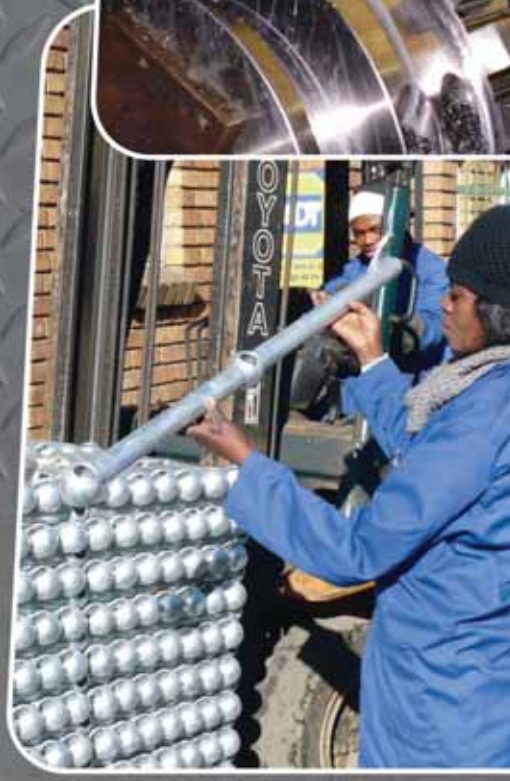

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The role of mathematics education in industry

In the late 1980s, the requirement of Latin for admission to legal practice was abolished. Up till this time South Africa was one of only a few countries that had this requirement, although many other countries, like South Africa, which had a strong Roman law tradition, had previously abolished it. The reasons usually given for Latin in legal training were wide and various: cultural enrichment, benefits to reasoning and logic and the understanding of a legacy of a wide range of legal words and phrases. Even in the late eighties, before our democratic era, many believed that abolishing Latin knowledge from legal education would favour blacks, although this was generally unfounded (see 'The Demise of Latin for Legal Practice': Dlamini, CRM: Consultus October 1988)

Many will see a close similarity between the Latin requirement for law and a sound mathematics education for engineering. Every branch of engineering requires a good understanding of mathematics. As with Latin in law, the absence or weaker understanding of mathematics can make engineering more difficult to understand and to practice.

It is common knowledge that some of the poor statistics related to mathematics education in the South African schooling system are extremely disconcerting: the low number of students who take mathematics as a subject, the high drop-out of learners, low pass requirements and the extremely poor rating of our mathematics education on an international rating scale. In this regard, South Africa is either rated last out of about 142 countries or second last, just above Yemen.

Education in South African schools, generally, and the poor mathematics achievements in particular, has been the subject of intense scrutiny and assessment. Many educationalists believe that our education system is too inflexible and more akin to highly mechanistic' industrial processes, where outcomes are based on strict adherence to procedures. We judge the education to be good if the statistics and data are considered good and bad if the statistics are bad. If we get better statistics and data next year, we believe our education system is improving. Surely, we should judge our education system on the capability of the education system to produce innovative and creative youngsters, who are equipped to be gainfully employed, with or without further training, in a profession or a trade, or in companies that they have created for themselves. If we single out extremely low proficiency in mathematics, the situation becomes increasingly concerning with regard to employing capable and competent engineers.

Sir Ken Robinson, the renowned British educationalist, believes that education must be a human system and not a rigid and inflexible 'industrial' system. Robinson maintains there are three main principles that allow learners to flourish: learners are children and are naturally different and diverse; curiosity drives human flourishing and education must be about learning and not passing exams. Teachers must facilitate the children's activities to stimulate curiosity and creativity in all the wonderful diverse ways that our environment offers. Teachers should be facilitators of curiosity and creativity, not followers of rigid curricula and adherence to strict regulations.

In a similar way, young engineers or technicians in industry, who are probably less than adequately educated in mathematics and thus less than adequately proficient as budding engineers, should be fostered, coached and mentored. If there is an innovative, flexible, curious and interesting approach by teachers in schools and supervisors and managers in industry to the work environment, good progress could be made to improve the dire situations. Mathematics and engineering must be made interesting and, dare I say it, fun. Mathematics is just about establishing and mathematically expressing relationships, not by undertaking loads and loads of calculations. Proving an hypothesis mathematically, and using this relationship to conceptualise innovative engineering designs and structures is extremely satisfying and it is our role to encourage and emphasise this achievement.

We have so many opportunities in which young engineers could be gainfully employed but it is going to take a serious review of how young engineers are currently employed and how more young learners can be encouraged to become engineers.

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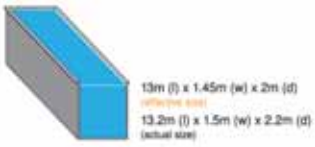

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