Chemical bodyguards
Protective coating feature

The great news for asset owners, designers and architects in this decade is the substantial developments made in the nature and appearance of protective coating systems for steel.

Both hot dip galvanising practice and protective paint coating systems have seen a wealth of new and improved processes that offer the steel specifier a new range of architectural and protective finishes.

Included in these are the design warranty systems available in the market today. These allow the specifier community to share risk with the system supplier.

The recognition of advances in protective systems has also seen advances made through the Australian standard AS/NZS 2312:2002, Guide to the protection of structural steel against atmospheric corrosion.

The following articles intend to highlight advances and to simplify understanding of current practices without the complication of proprietary brands.

Specific information on suitable suppliers can be found through the Galvanizers Association of Australia and the Australian Paint Manufacturers Federation.

Exterior environment

Architects are looking more to structural steel as a focal point in building design. Steel subject to high public scrutiny requires coating systems to have both high visual impact and long-term performance.
Much of our building activity, from major high-density residential developments and large retail complexes to infrastructure has been along our coastline, subjecting external steel to a corrosive environment.

Given that external steel is exposed to continual weathering and chemical attack (hot-cold temperature cycling, UV rays, rain, hail, wind, dust, airborne chemicals such as salts from the coast and airborne acids from transportation, industrial and domestic pollution), the coating system must offer a high degree of resistance to moisture, chemicals and abrasion.
So how do we choose the right coating system to protect steel? The answer lies in a coating system with components that deal with the major causes of steel corrosion: salts, water and oxygen, and the major causes of coating breakdown: water, dust and UV rays.

Paint Systems

One effective way of protecting architectural steel against corrosion is to use a three-coat system consisting of a zinc-rich epoxy primer, a high-build epoxy intermediate coat and a polyurethane topcoat.

Zinc-rich epoxy primers contain high levels of zinc metal powder. The zinc particles in contact with the surface of the steel will (in the presence of moisture, ions and oxygen) corrode in preference to the steel. Think of it as the chemical "bodyguard" of the steel! And unlike hot dipped galvanising, the zinc-rich epoxy primer has been formulated to have high adhesive bond strength to a specific intermediate coat.

The intermediate coat

The high build epoxy intermediate coat provides a barrier to corrosive elements thus prolonging the life of the zinc-rich primer and the steel underneath. Epoxies not only make excellent barriers to many chemicals and moisture, but they have exceptional adhesion, which is why Araldite and other two-part adhesives are generally epoxy based. Epoxies are also more economical compared with other resin systems.

Epoxies have, in fact, only one slight drawback – their surface deteriorates from exposure to the sun's UV rays. This deterioration is called "chalking". But chalking only affects a thin layer of the coating surface; because, once the powdery "chalky" film develops, it prevents the UV rays from penetrating the coating film and causing further damage. Unless this chalking layer is constantly removed, chalking does not detract from the protective ability of epoxy coatings, but it does detract from their aesthetic appeal. For this reason, epoxies have been used only as intermediate coats for some years. Where aesthetics are an important issue, topcoats based on resins that are resistant to UV degradation are used.

Polyurethane topcoats

The topcoat is generally a two-pack polyurethane, but can be an acrylic. Two-pack polyurethanes are most commonly used as topcoats in steel coating systems, due to their high aesthetic appeal. They offer the best balance of properties including:

- high and consistent gloss
- extremely low dirt pick-up
- excellent "self-cleaning" in rain
- high abrasion resistance, and
- high resistance to repeated cleaning with graffiti-removing agents (this feature is often termed "graffiti resistance").

From an architect's viewpoint, polyurethanes make an outstanding choice for steel because of the above properties together with:
- availability of a broad range of colours – colour versatility
- ease of maintenance and recoatability
- suitability for internal as well as external steelwork – design versatility

From an applicator's point of view, polyurethanes also offer:
- ease of spray application
- excellent flow out
- brushable formulations
- ease of recoating and maintenance.

New developments

The need for coatings with higher visual impact has seen the development and refinement of exciting new technology; polyurethanes using brilliant metallic pigments. Unlike automotive coating systems that require both a metallic base coat and a clear topcoat, today's new metallic polyurethanes can be used with or without a clear coat. Without a clear coat, such coatings offer a subtle semi gloss finish.

One project that featured this new coating system was the Olympic Memories Program, in the forecourt at the Sydney Olympic Stadium at Homebush, New South Wales. The Architect, Tony Carro, presented a challenge to the suppliers of the coating system to come up with something that would give an appearance similar to that of colourful anodised aluminium drinking cups that were popular in the sixties. Other necessary attributes were high durability in a prominent and busy area and long corrosion protection. Ian Clark of Dulux presented Tony with samples and specifications for Quantum® FX and to this day the coating system continues to impress visitors and provide excellent protection to the steel.

Emergence of consultants
The specifier's specifier

The plethora of coating systems now available has made the task of researching and specifying the right products and coating systems more challenging. Fortunately, major suppliers have shifted focus towards providing qualified specification consultants for architects and engineers. These consultants on the whole ensure that appropriate surface preparations, primers, intermediates and topcoats are specified for maximum performance and long-term aesthetic appeal. The coatings consultant, working closely with the architect or engineer, considers:
- design – the colour and finish required
- environment – the proximity of the project to the coast and corrosive airborne salts
- use – exposure to wear and tear and graffiti management
- life cycle, maintenance and accessibility – how easy or difficult is it to access, inspect and maintain
- cost – initial cost of product and application balanced with cost of maintenance over the design life of the structure will always expose the false economy of using cheaper materials and lower film builds.

Specification consultants usually have a good working knowledge of relevant standards such as Australian Standard AS/NZS 2312:2002, Guide to the protection of structural steel against atmospheric corrosion by use of protective coatings. A good specification makes reference to this standard, and, wherever appropriate, conforms to the appropriate sections of this Standard.

This standard defines durability as the approximate number of years to first maintenance in a given "atmospheric corrosion category", roughly described by distance from coast, humidity and atmospheric pollution. It also offers coating systems based on generic product types, characterised by the resin binder. Thus there are systems based on epoxies, polyurethanes, acrylics, alkyd enamels and chlorinated rubbers among others. Each coating is specified by a dry film thickness specific to it. Note that the AS/NZS2312: 2002 specifically mentions coverage on edges and recommends that all sharp edges be removed, to ensure uniform film build. If rounding of the sharp edges is not practical or possible, the use of "stripe coating" should be specified. "Stripe coating" means the brush application of an additional coat on the sharp edges.

It is possible to use AS/NZS 2312:2002 to write specifications based on generic product types, but caution must be exercised when doing so! Variations in tenders provided by application contractors will have to take into account comparisons between products and hence differences in prices, performance and colour fastness will complicate the exercise. It is much easier to have all contractors base their tenders on the same set of specifications using the same products so that differences in application costs can be readily identified.

However performance based systems may be the way of the future and this should be the subject of enquiry on the coatings consultant or paint manufacturer.

The ZRCC (Zinc Rich Coatings Council) recognised the need for standardised coating specifications that would minimise variations in minimum requirements, decrease confusion amongst applicators. The ZRCC has approached Standards Australia with a view to having a series of standard specifications produced, one for each of the most widely used single-coat and multi-coat systems. The draft of the first in the series of standard specifications has been out for public comment and should be published in the near future. It is titled: Application specification for coating systems; Part 1: Single coat inorganic (ethyl) zinc silicate – solvent borne. These new Standards should be a very useful tool for specification writers, architects and engineers.

Key factors to consider

Cost

Cost is always a major issue, although the specification of a protective coatings system should always be influenced by the required benefits rather than the cost. The application of coatings to protect steelwork is an essential part of ensuring a structure can survive its intended design life.

Paint as a percentage of total investment in a project is approximately 0.1 percent of costs. That figure appears to be applicable irrespective of market sector or geography because the major items associated with the commissioning a significant new asset are sourced globally or have pricing influenced by global factors. So whilst acknowledging that paint is a cost, the reality is that a 30 percent 'saving' on paint will only represent a 0.03 percent saving on total investment costs.

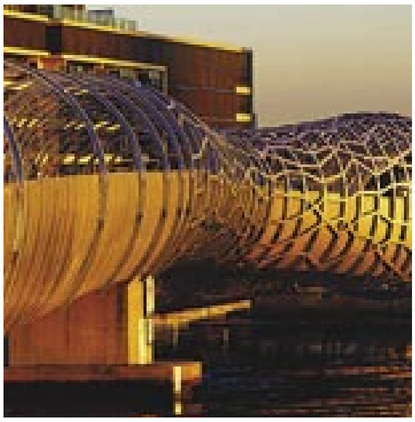
This may recoup some small financial gain in the delivery of a new structure, but there is likely to be a more significant negative impact to the owner or operator for ongoing maintenance and repairs over the lifetime of the asset. However, correct selection of coating materials and their specification at the design stage can yield greater financial benefits in the longer term.

Health, safety and the environment

Health, safety and the environment (HSE) has been a major focus over the last decade and many traditional anticorrosive coatings containing red lead, coal tar pitch and isocyanates are no longer acceptable due to their potentially hazardous nature. In addition, legislative requirements to reduce the emission of potential ozone depleting materials have reduced the volatile organic content (VOC) of paints and coatings.

This has resulted in the proliferation of "greener" coatings such as water-based technology and a higher solids formulation for solvent based coatings, which emit less VOC. Specifiers must always be aware of local legislation governing the use of protective coatings, as well as the health and safety implications to users. Appropriate use of personal protective equipment (PPE) is always necessary and should be considered when selecting a system.

Sustainable design and coating life cycles



One of the most significant considerations is design life. If the life of the coating system is considerably lower than the design life of the structure then at some point the coatings will need to be replaced – sometimes on more than one occasion. Such maintenance may constitute major refurbishment involving the re-blasting and re-application of coatings.

More non-renewable materials and more energy will be consumed in re-instating the corrosion protection. Realistically, specifying long lasting (both in terms of corrosion and colour/gloss durability) systems at the design phase will help to limit the environmental impact of corrosion protection over the lifetime of a project.

Maintenance of paint coatings should also be an initial consideration and can be made part of the contract.

Adoption of the recognised ISO 12944 Standard (www.infrastructure-coatings.com) will also ensure that cost effective solutions can be achieved alongside the objective of improved sustainability.

Application

Application is just as important as the paint formulation. It is critical that the application and preparation be in accordance with the manufacturer's specification for warranties to apply.
Shop application, as opposed to on-site or in-situ painting, results in far better long-term performance and corrosion protection, due to the easily controlled environment in which the steel was prepared and painted.

Summary

Paint system specification is a job for experts. The right protective coating system depends on where the project is located, where the steel is going, and what it will be used for. Coatings consultants can put together specifications that will meet performance requirements. Paint companies may also be prepared to offer performance based systems and this should be investigated. Surface preparation and application are as important as the coating itself.

HIGH PERFORMANCE TOPCOATS SPECIFYING THE RIGHT POLYSILOXANE*

New high performance topcoats are helping to achieve cost effective, long lasting aesthetics and long term durability for protective coating systems, even in highly corrosive environments.

Organic coatings such as epoxies and polyurethanes degrade over time as a result of exposure to ultra violet radiation or by chemical attack. Research and development work has yielded new materials which now accommodate the need for both improved durability, and provide lessened environmental impact by utilising higher solids and lower solvent content.

The invention of modified polysiloxanes is the most significant coating achievement of recent times. Polysiloxane coatings have been used in the industry for many years for specialized high temperature applications. They were unsuitable for normal use because of incompatibility with organic coatings and their brittleness.

However, Ameron Coatings was able to incorporate organic entities onto a polysiloxane backbone giving a synergy of the UV and chemical resistance of polysiloxanes, with the system compatibility and ease of application of organic coatings, such as epoxies and polyurethanes. The patent for this initial product was taken out in 1989 and the first large job was maintenance of the Peace Bridge across the Niagara River in 1993.

The first product, an epoxy modified polysiloxane showed exceptional UV resistance coupled with excellent chemical and corrosion resistance. Ameron claims that the excellent all round properties of this product, PSX700, have still to be matched by any other organic / polysiloxane combination.

Polysiloxane silicon based inorganic coatings offer superior gloss and colour retention and are much more resistant to degradation. Interfine® acrylic polysiloxane technology from International Protective Coatings has been developed to provide these core benefits and when used as part of a high performance system, can demonstrate enhanced performance characteristics.

Polysiloxanes can be modified using a number of organic materials and by choosing an acrylic modification of the polymer, this material can provide a backbone that not only enhances finish coat aesthetics but also the long term durability against coating breakdown.

The correlation between hardness, flexibility and internal stress needs to be considered when selecting an appropriate polysiloxane system. The modification of a polysiloxane with an epoxy variant tends to give fast cure and early hardness at the expense of long term flexibility. However, these harder films with higher internal stress show reduced flexibility.

In combination with good abrasion and impact resistance properties, this low film stress means reduced damage during service and long-term film flexibility, allowing application to structures where some flexing movement is expected. Interfine Acrylic polysiloxanes can offer lower internal stress, hardness and resistance against UV degradation, to deliver performance on long term environmental exposure.

Laboratory testing shows that Interfine acrylic polysiloxane technology demonstrates superior durability compared to conventional systems. Importantly, the flexibility of the acrylic modified polysiloxane does not change with time suggesting that little, if any, further degradation of the coating is taking place on ageing. This is in contrast to epoxy modified polysiloxane which becomes more brittle with time.

These features, the core benefits of the Interfine technology, help extend the lifetime of the coatings system and increase the overall time before the first maintenance.

Sound quality assurance principles and recording are ensuring longer life performance and aesthetics for coatings on structural steel. The performance of coated steel cladding has given architects and engineers confidence in this building material. The recent improvements in protective paint coatings will provide similar confidence in their use as both protective and aesthetic finishes for steel structures.

The architectural roof structure at 126 Phillip Street in the Sydney CBD. The external surface has been corrosion protected by applied coating systems with a minimum durability (coating life to first major maintenance) of 25 years as defined by AS/NZ 2312 System Designation, PUR5 protects the external surface. The coatings are a three-coat sprayed paint system applied to a Class 2.5 abrasively blasted surface. The first two coats are polyamine air cured epoxies and the top coat aliphatic acrylic.