# NEW POLYMER TECHNOLOGY IMPROVES DURABILITY AND CONSTRUCTABILITY OF COATING FOR STEEL STRUCTURES

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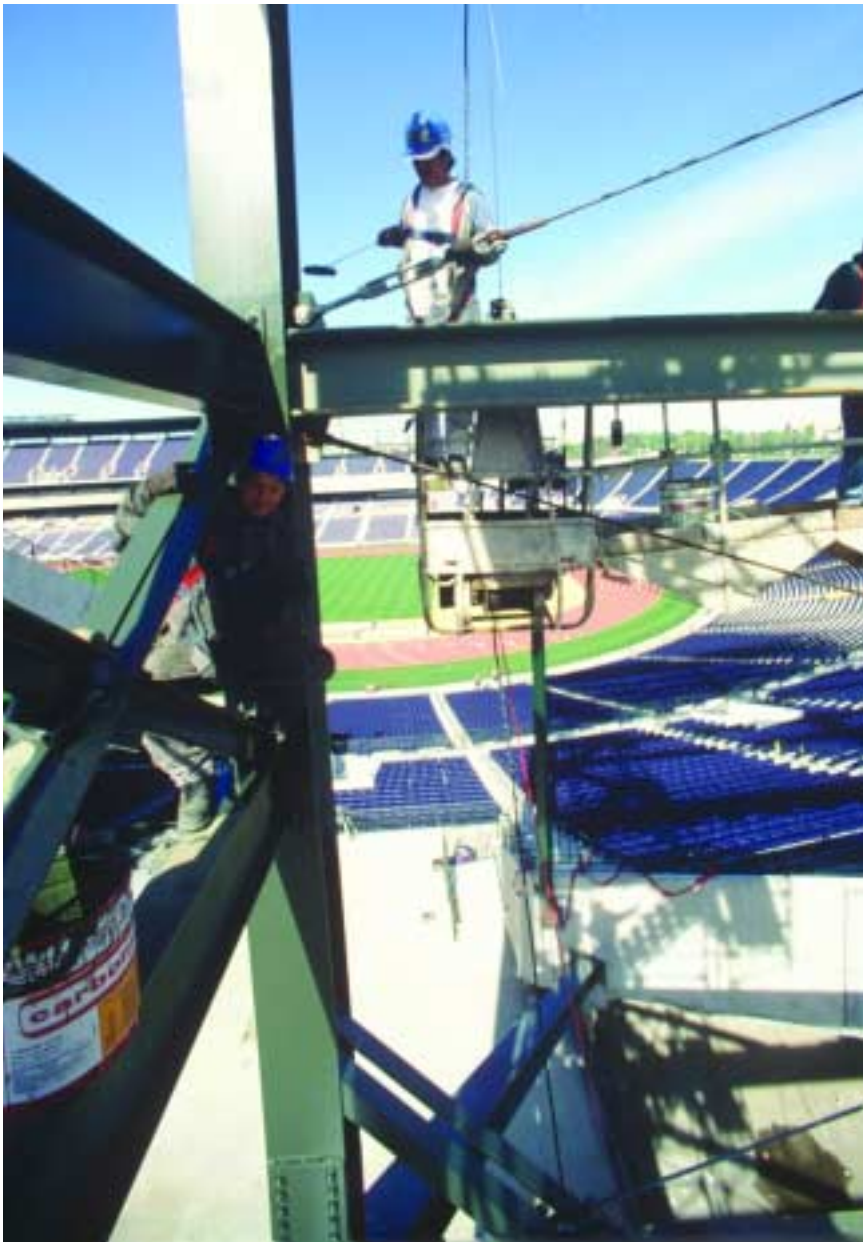
Coating formulations for exposed structural steel have changed dramatically over the years, so much so that steel requiring maintenance painting today was almost certainly not protected with high performance coatings. Fast dry alkyd shop primers and older lead based formulations provide only a fraction of the longevity of the top performing zinc rich systems. This paper will discuss four important characteristics of coatings for exposed steel parking garages, corrosion control, constructability, cosmetics and coatings for fireproofing.

In the 1960s and 1970s American industry began to adopt high performance coatings. Results of accelerated corrosion testing with traditional oil based coatings as the controls indicated these new formulations would be great improvements. The benefits were immediately obvious in the most corrosive industrial environments. (Re-paint cycles of only a few years spanned the job assignments of decision makers.)

Life-cycle cost benefits in mild exposures were not as obvious. Consequently, architectural applications were slow to convert to the improved technology. Real time exposures have since proven the predictions of lab testing.

Today it is common to see high performance coatings specified for parking garages, stadiums, air terminals and other architecturally exposed structural steel applications. Life-cycles have been extended and maintenance painting costs mitigated to a fraction of that for earlier paint systems. Formulations with metallic zinc in the primer are responsible for the dramatic cost savings.

*Inorganic zinc and vinyl coatings applied 29 years earlier to a Missouri bridge. Today 90% of bridge owners use zinc primers for construction.*



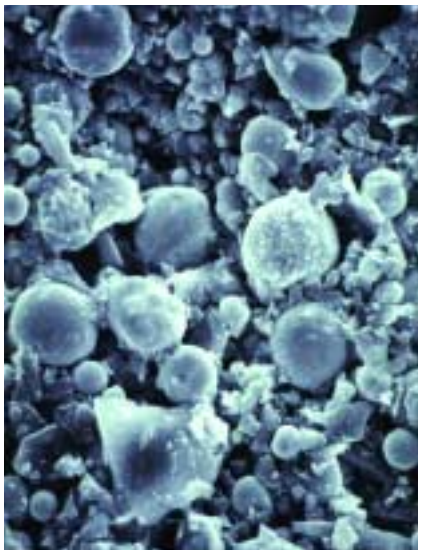
## Corrosion control

The mechanism of zinc protection is significant in life-cycle cost benefits. The ability of metallic zinc to protect galvanically extends maintenance cycles and enables low cost maintenance painting procedures. Zinc, being more reactive than iron, will oxidize in preference to the formation of rust. The oxidation products of zinc do not expand like red rust and they passivate the surface to reduce the demand for further oxidation. This mechanism retards corrosion beneath the coating and prevents undercutting corrosion. Primers without zinc allow sub-film corrosion and do relatively little to prevent propagation of rust along the surface. The zinc primer becomes a permanent asset on the structure. Maintenance painting becomes maintenance of the coating.

Two types of zinc rich primers are used to obtain high performance, inorganic zinc and organic zinc. Inorganic zinc utilizes a silicate (glass) binder to secure zinc particles to the steel surface and in the film. This is a wide departure from traditional coatings like alkyds, epoxies and urethanes which are classified as "organic", or carbon based. Organic zinc primers may use several of the mentioned binders but the epoxy is by far the most practical and common type.

The inorganic zinc category is widely regarded as the top performing type. Performance specifications for inorganic zinc, such as AASHTO M 300 for bridge primers, call out for 5,000 hours of salt fog exposure resulting in no rust and no rust creep (undercutting) at the scribe mark. In perspective, traditional coatings are completely destroyed in this test before the inorganic zinc shows the first indication of rust. Many inorganic zinc primers may perform well beyond 5,000 hours but for most applications, testing to 5,000 hours is deemed adequate to weed-out substandard formulations.

*(Left) A 5,000 hour epoxy zinc/polyurethane system was applied to the Olympic Stadium in Atlanta. (Bottom) SEM image of inorganic zinc shows zinc particles and glass binder matrix. Handling damage resistance is outstanding for inorganic zinc as it burnishes on impact rather than chipping. Unfortunately the tensile strength of inorganic zinc is lower than other coatings. Epoxy and urethane finish coats become susceptible to handling damage when applied over inorganic zinc.*



In the organic zinc category, performance specifications commonly refer to SSPC SP 20. This also uses the salt fog, however only to 1000 hours. There is a much greater disparity between expected life of good and poor organic zinc formulations than with inorganic zinc primers. It must be understood that with finish coats applied, good organic zinc systems approach the performance of inorganic zinc systems.

## Constructability

Many industrial applications call for inorganic zinc primed systems for the primer's outstanding performance and fast-dry shop applications. Field finishing is usually performed near the end of construction. This schedule is typical for most bridge construction projects. The inorganic zinc offers several key features to make this approach practical;

- Inorganic zinc allows designs with "Class B" friction connections.
- norganic zinc primed steel can be handled within minutes of application.
- Inorganic zinc retains an open recoat window allowing finish coats to be applied years after priming without the need for sanding or abrading the surface.
- Inorganic zinc does not chip during handling and erection.
- The best available performance is attained with inorganic zinc.

Fabricators love the product as long as the finish coats are applied in the field. Shop finishing inorganic zinc creates a number of concerns for the fabricator and erector. Some of the wonderful constructability features of inorganic zinc are lost when finish coating in the shop. Although quick dry for handling, topcoat times are often 24 hours or more as the inorganic zinc must develop adequate hardness and full cure to support finishes. Low humidity conditions during some seasons exacerbate the cure hardness delays.

The features that give damage tolerance to inorganic zinc make it susceptible to handling damage when finish coated. Inorganic zinc should be field finished, however many job sites are not suitable for spray application of coatings. In these cases shop finishing is appropriate and this is where the new technology organic zinc comes in.

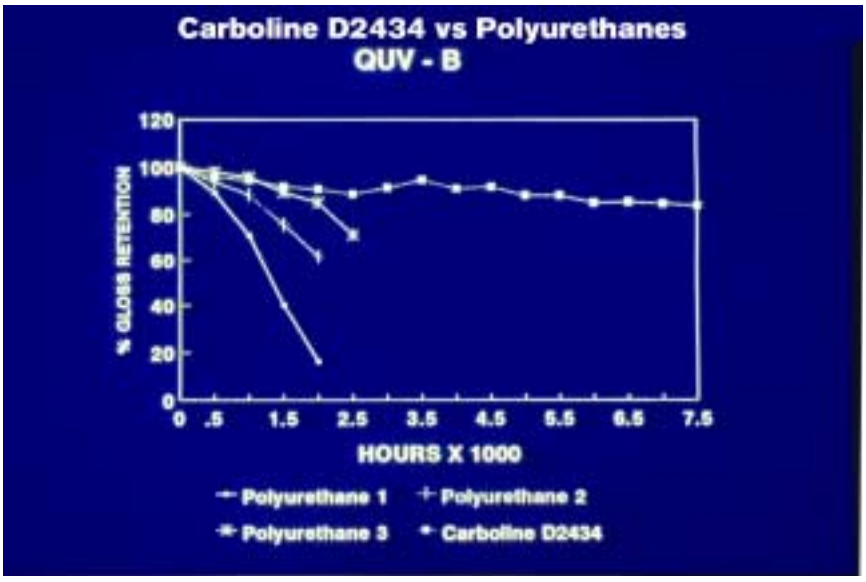
Engineers have been reluctant to sacrifice their inorganic zinc performance levels at the cost of constructability and shop efficiency. Thanks in part to environmental regulations now they can have both.

In 1978 and again in 1990, the Federal Government passed laws restricting formulations of coatings. These regulations sent formulators back to the laboratory to create compliant products. Fortunately for us, resin technology had evolved so the chemist gained latitude for creativity. The competitive marketplace demanded more than simple replacements to the old technology. Wise formulators were able to improve both performance and constructability. Here are some examples of what can be expected of today's technology.

- Low solvent and low hazardous air pollutant content.
- Epoxy zinc primers with 5,000 hour salt fog performance.
- High-build coatings that provide three-coat thickness in two coats.
- Wet-on-wet applications, "Quick Turn" coatings allow 24 hour turn-around from blast to ship.
- "Class B" friction rated epoxy zinc.
- Epoxy zinc primers with unlimited re-coat window.
- User friendly, forgiving formulations, tolerant of mudcracking, solvent trapping etc.

These formulations can provide regulatory compliance, improved performance and low cost maintenance options to minimize life-cycle cost. The improved constructability features will help reduce initial cost.

The ideal parking garage coating system consists of an epoxy zinc rich primer followed by a high build polyurethane finish. A properly formulated epoxy zinc/polyurethane system will provide over 30 years of service before first maintenance in moderately corrosive environments. Furthermore, future maintenance painting will be relatively inexpensive and include spot priming and




*The D2434 fluorourethane demonstrates far superior ultraviolet light resistance to traditional polyurethanes in the U. V. cabinet.*

a full finish coat, primarily to freshen appearance. Products with good constructability features will allow fast construction cycles. These products are being used today in many exposed structural steel applications.

## Cosmetics

Zinc rich primer technology has changed the reason for repainting. Old technology coating systems failed because of corrosion not aesthetics. With 30 or more years of corrosion protection, the weak point in the system becomes the finish appearance. Many polyurethane finish colors do fine for 20 to 30 years in all but the most aggressive sunlight exposures. Vivid colors can no longer use heavy metal pigments like lead and chrome and this compromises their durability. Fluorourethane finishes have been formulated for these situations and where long term color stability is needed. The Kynar brand is an example of this coating classification. This baked-on "ultra-durable" coating has been used for years on metal façade and roof applications.

New technology fluorourethanes can be applied by conventional spray techniques. Now the designer has the option to incorporate color into exposed structural steel concepts that will be corrosion free and look good for a long time.

*Stat Oil of Norway uses a zinc rich primer/epoxy and fluorourethane finish to protect against the severe North Sea environment. Maintenance painting is expensive there and vivid colors for visibility and safety are important.*

## Coatings for Fireproofing

Coating polymers are now used to provide fire protection to structural steel. Designers need not hide structural members because of requirements in building codes to apply fibrous fireproofing products. Intumescing fireproofing coatings are increasingly used on architecturally exposed structural steel applications. Extensive testing has extended the capability of intumescent coatings to protect many types of steel structures. Unlike low density types, these products look and apply like other protective coatings and have the option of being applied in the fabricators shop.

Intumescent coatings look and feel like thick paint. When exposed to fire they expand and char to insulate the steel from heat transfer. Three hour fire protection is possible on both interior and exterior grade materials.

Long term durability is achieved with these systems utilizing the appropriate primer. Finish coat options include the ultra durable fluoropolymer previously discussed.

## Summary

Now with 30 or more years of maintenance free service available from coatings, architects are considering the design elements of exposed structural steel in a new light. Structures like Coors Field and Camden Yard can be designed without fear of leaving owners with an albatross of maintenance painting. Coating suppliers in tune to the competitive marketplace use new technology raw materials to build user friendly features into these high performance products. Low initial cost combined with outstanding life-cycle cost benefits will launch steel structures into the next century.