



Tufts Health Plan Facility. Design Engineers: Hybrid Parking Structure.

COATINGS *f*or Parking Structures

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Structural steel has long been a preferred building material among structural engineers for use in constructing parking structures. Its limitations have been based upon the constant battle to prevent carbon steel from returning to its original form: iron ore. Both concrete and steel have seesawed as to what makes the most sense in terms of first cost and life cycle maintenance. This article will address coating systems for structural steel parking structures, the constructability and design issues overlooked by many engineers that could enhance coating and ultimately structural integrity of parking structures, increasing the use of structural steel as the material of choice.



Burlington Vermont International Airport parking structure. Design Engineer: Hybrid Parking Structures.

In the past, little attention was paid to coating design, as coating technology was relatively primitive. The use of red lead and oil and primers in the 60s and 70s top coated with linseed oil based coatings were one of a very select few coating systems available. In the mid to late 70s the introduction of zinc rich primers entered the marketplace providing cathodic protection for structural steel. Epoxy coatings became a preferred material as they provide vapor barrier protection, thus protecting the cathodic protection system of zinc rich primers. This zinc rich and epoxy coating system approach is now the accepted coating scenario for most parking garage structures today. One of the most overlooked items is the relationship between the coated structural steel and its interface with concrete. Engineering firms would use structural steel almost as a sacrificial material by designing major construction and control joints directly over top flanges of load carrying beams. Upon the failure of

these joints, water would exit directly to the steel located below, resulting in increased frequency of deterioration. With the use of CAD design and imaginative engineering, parking structures today have evolved into hybrid structures. Hybrid Parking Solutions of Watertown, MA, encompasses this approach. Through the use of steel framing, precast double Ts and particular attention to joint detailing, this parking structure and the coating systems that accompany it provide long-term solutions for clients.

The design engineer needs to evaluate how to keep water and water runoff from direct contact with steel substrates to enhance coating protection and reduce long term maintenance for the client. The use of black iron bolts for connections has long been a problem in designing steel frame structures. Black iron bolts once pulled from their kegs during erection are laden with grease and oil that must be removed prior to application of

a coating. Not only is removal of oil a paramount necessity, but the profiling of these nuts and bolts also must be addressed. We have long encouraged the use of galvanized fasteners, thus eliminating questionable field preparation that may marginalize the performance of the coating systems. The use of galvanized fasteners makes life easy for the erector, the field painter and subsequently the owner, as epoxy coatings can be adhered directly to the galvanized surface with minimal preparation of solvent wiping prior to painting.

Another troublesome detail due to building code requirements is welded moment connections. Much of the time, the bottom flange must be welded to a column where a block out by the steel fabricator is a necessity. This block out can range in width from 3-8". With the use of urethane zinc rich primers, field-testing has been performed to determine the "heat affected" zone of the weld area.

These



Route 128 Intermodal Center & Parking Structure. Design/Builder: Perini. Design Engineer: Hybrid Parking Structures.

block out areas can be held to 1 to 1½" hold back from where the weld should occur (depending on column size), thus resulting in less touch up in the field and less burn back of the coating upon the performance of the full penetration weld.

Fireproofing, although not often used, is also a coordination issue, which needs to be addressed with the coating system. The W R Grace Company and Tnemec Company are two manufacturers that have researched which options should be addressed relative to proper priming and cementitious fireproofing products. The use of high density fireproofing (i.e. 45-50 lb. density) is the most common and recommended density of fireproofing product for exposed steel framed parking structures. The higher the density of fireproofing, the higher the Portland cement content resulting in better long-term performance when exposed to freeze thaw cycling. Although aesthetically pleasing, the use of intumescent fireproofings are somewhat costly and may or may not provide long term fireproofing protection given exposure requirements. Proper selection of the correct primer to address field applied fireproofing should be properly coordinated with the structural drawings and the cementitious fireproofing sections of the specification. Due to the myriad of primers available, proper selection is critical.

Coating System Approaches

Surface Preparation

When asked for coating system recommendations, the one important question is: "What is the customer's expectation for maintenance?" Over the years, lead and oil based coatings have long been used with marginal results, i.e. 8-10 years of life expectancy. In many cases, mar-



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ginal surface preparation was employed, i.e. SSPC-SP3 Power Tool Cleaning. The use of a long oil alkyd primer over SSPC-SP3 cleaning topcoated with high performance acrylics or high solids alkyd topcoats would result in a 5-8 year window of success before touch-up or recoating would be in order. Today the use of zinc rich primers, epoxy intermediate coats and urethane finishes has extended coating life up to 25-30 years.

More common today is viewing where real money should be spent in terms of surface preparation. The use of SSPC-SP6 Commercial Blast Cleaning should be the starting point for most parking structures. Removal of mill scale is a key to long-term success of the specified coating system. In years past, when Hand Tool (SSPC-SP2) or Power Tool (SSPC-SP3) was used, mill scale reacted with moisture and curled off the base metal, removing itself and the coating system. It is the authors opinion that any preparation less than SSPC-SP6 Commercial Blast Cleaning is a false economic choice and will most likely result in premature coating failure. In the design/build world, surface preparation can be an easy target for cost reduction. But when all parties exit the scene, the owner is at risk for a costly repaint in the near future.

Zinc Rich Primers

The introduction of zinc rich primers provided cathodic protection to carbon steel in the 70s, inviting a new approach to corrosion protection in lieu of red lead

inhibitors. Today, widespread use of zinc rich primers is commonplace in parking structure construction. The focus became, what generic zinc rich product provided corrosion protection yet increased though put at the point of fabrication? Inorganic zincs, although quick to handle (if primed only), were a good candidate but problematic when multiple shop coats were called for, mainly due to a 16 hour cure window to properly cure the zinc for top coating and affinity to minor amounts of oil contamination. Single component inorganic zincs were formulated to speed cure response, but after significant failures by numerous manufacturers, these products faded rapidly.

Urethane zinc rich primers, both one and two component versions appear to be the material of choice. Presently, urethane zinc cure to recoat in 3-4 hours will not mud crack if film thicknesses are exceeded. It provides as much as 10,000 hours salt fog per ASTM B117 and is Class B for moment connections. The fabricator's coating facility can increase shop through put with the rapid recoat capabilities of urethane zinc rich, netting faster turn around for the customer.

Top Coats

Topcoat choices are numerous today, and one must evaluate where the parking structure is to be located and what is the expectation for color and gloss retention as part of the design criteria. Most frequently, epoxy and urethanes are



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chosen for a topcoat over zinc rich primers. They both are vapor barrier materials and impervious to moisture and chloride intrusion when de-icing or water and snow are present within the structure. Polyamide epoxies are most commonly used, but perimeter elements require urethane protection as a UV screen to prevent chalking and fading of the finish. Performance of a zinc rich polyamide epoxy system should have a minimum of: (Salt Fog) ASTM B117 10,000 hours, Adhesion ASTM D 4541 800 psi, Humidity ASTM D 4585 1000 hours, static fatigue – Class B no less than .50. These starting points for performance are the bases for estimated 25 life span of the coating system.

High Build Aliphatic Acrylic Urethanes are the next material of choice. Aliphatic urethanes of the two-component formulation have long been used as a direct topcoat over urethane zinc rich primers. They provide UV protection in addition to the same vapor barrier protection provided by the polyamide epoxy-

ies. There UV resistance is 10 times greater than a polyamide epoxy and therefore provides color and light stability for the client where architecturally exposed steel is an aesthetic requirement. Their performance should be specified with the same performance standards noted above.

Using the combination urethane zinc rich primer, epoxy polyamide intermediate and aliphatic urethane topcoat can provide as high as 30-year life expectancy with the proper design. Numerous projects throughout the United States have used this system successfully for the past 15 years and have experienced less than ½ % touch up required.

In summary, these combinations of material highly successful and have built a strong foundation of their use and acceptance throughout the steel parking structure industry. New technologies on the horizon

incorporate the use of single component moisture cured urethanes that will provide more user-friendly installations and faster recoat windows. Although new to the American market place, single component moisture cured urethanes have been used successfully throughout the European community for the past 20 years. Given the proper and thorough design of the parking structure to channel water away from carbon steel elements and the correct erection procedure using beam clamps, galvanized fasteners and proper site storage all combine to provide long term performance for structural steel framing. It is important to note that many elements of design must be incorporated and thought through prior to construction. A solidly written specification and coordinated contract document can make the project and its overall performance a better product for the customer. Many of these details get overlooked by the design community and thus result in field problems. Coating systems are one component that can increase life expectancy of parking structures but only as a compliment to appropriate design.

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Worcester Municipal Parking Structure. Design Engineer: Hybrid Parking Structures.