Polyaspartic Coatings

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Reducing the cost of shop-painted steel bridges by improving painting efficiency.

PROTECTIVE COATINGS HAVE been used to mitigate corrosion on steel bridges for more than a century.

The state-of-the-art for the past several decades now has been a three-layer system consisting of an organic or inorganic zinc-rich primer, an epoxy intermediate coat and a polyurethane finish coat (commonly abbreviated as ZEU). Each layer provides specific protection mechanisms working in unity to prevent corrosion:

1. The zinc-rich primer provides galvanic protection, with the zinc preferentially "sacrificing" itself to protect the steel.
2. The epoxy layer provides barrier properties by reducing the permeability of water, oxygen and salts through the coating.
3. The polyurethane topcoat's main function is to protect the underlying coatings from the sun's ultraviolet rays while also providing abrasion and chemical resistance.

Economics and schedule impacts have driven multiple state and local departments of transportation (DOTs) to apply all three coats in the shop for new steel bridges. This has shifted the painting responsibility to steel fabricators or blast and paint shops. For fabricators, painting provides value-added work but can also create additional scheduling complications.

Applying three coats of paint is a time-intensive process. Each layer of paint has a minimum recoat time, which is the minimum amount of time before another layer can be applied. The recoat time is dependent on product chemistry and the degree of cure required before subsequent coatings can be applied. Environmental conditions also have a significant impact on recoat time. For instance, inorganic zinc-rich primers can require

Bridge #5160, which carries Main St. over the Little Madawaska River in Stockholm, Maine, was repainted with a PAS system.

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The Maine bridge project is a simple-span design with four steel girders spanning about 100 ft.

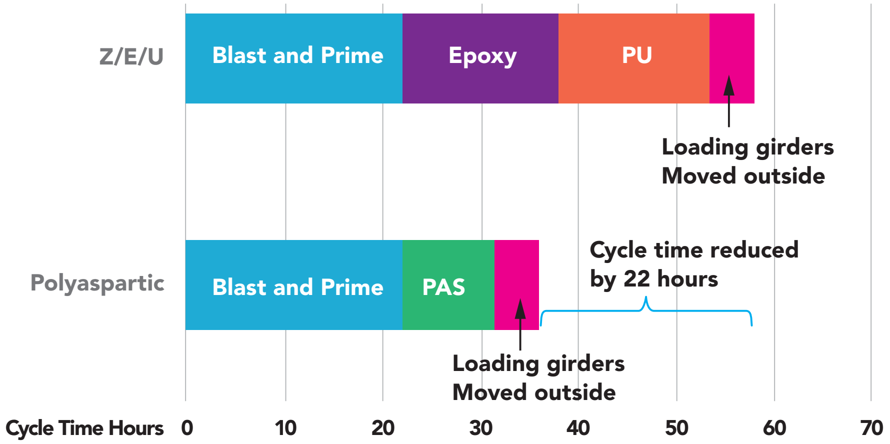


Figure 1. A graphical representation of the cycle time difference between the PAS system that was used on the Maine bridge project and a typical ZEU system.

more than 24 hours at low humidity to cure before subsequent coats can be applied, thus reducing productivity. In addition, the total time to apply a ZEU system in a shop setting can vary significantly depending on the available shop space and number of painting shifts per day. The longer the recoat time, the longer the product takes up space waiting, resulting in less product that is able to be handled. Depending on work load and scheduling, a fabricator may subcontract out painting due to the bottleneck that applying multi-layer coating creates in the paint shop.

Polyaspartic Solution

Advancements in coating resin technology have improved painting efficiency. More than 20 years ago, polyaspartic (PAS) coating resins were invented by Covestro. This new coating resin replaces the "polyol" or paint resin in the "A-side" of two-component polyurethanes.

PAS coatings bring two important application and physical property advantages:

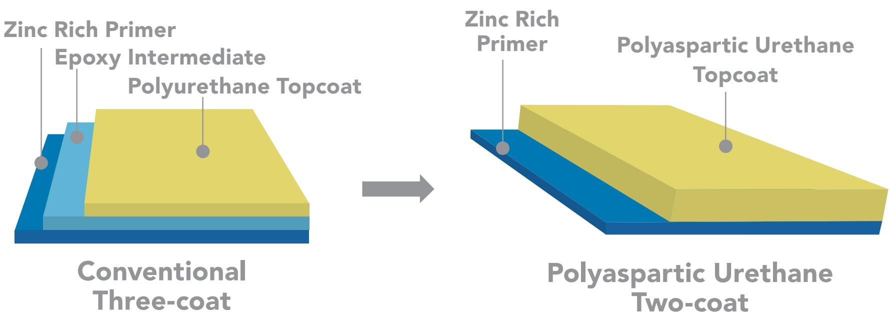
- In general, PAS coatings offer fast curing with a reasonable pot life (useable time to apply the coating). Typically, these coatings are dry-to-handle in one to two hours at 75 °F and 50% relative humidity, while having a pot life between two and three hours. By comparison, polyurethane coatings are dry-to-handle in six to eight hours, with a two- to four-hour pot life.
- They can be applied at higher dry film thicknesses (6-10 mils), which is much higher than polyurethanes (2-5 mils). The larger film build tolerance of PAS coatings allows for more forgiving application when painting complex geometries, as well as a reduction in the number of coats needed to provide corrosion protection. For instance, a ZEU three-coat system can be replaced by a two-coat system of zinc-rich primer with a PAS topcoat at the same overall film thickness.

PAS coatings are applied by the same means and methods as polyurethane coatings: spray, brush and roll. Their color and gloss retention is equivalent to polyurethanes, but they deliver better edge retention and cure significantly faster. These application and physical property advantages have been documented to increase painting productivity while reducing project costs without sacrificing corrosion protection. PAS coatings have become common in a number of different markets that shop-paint steel, including oil and gas, stadiums, railcars and structural steel.

PAS coatings have also been used in the steel bridge market for more than 15 years, and many of these applications have been in field maintenance painting. Since the early 2000s, a number of state DOTs have used PAS two-coat systems in this manner—e.g., Virginia, Maine, Connecticut, Michigan, Maryland, Pennsylvania, North Carolina and Kentucky—many of whom use salt liberally in the winter. In terms of total structures painted with PAS coatings, the Virginia DOT currently has the largest number for any one state, with more than 150 bridges.

The system has proven itself. The Connecticut DOT quantified the cost benefit for field applications of PAS coatings to show a cost reduction of up to 20% and a greater than 30% improvement in maintenance painting efficiency when compared to tradi-

A Virginia DOT project—I-64 over Simpson Creek in Clifton Forge—was repainted with a PAS system in 2005 and has experienced miminal rusting after 12 years in service (above photos and bottom-left photo on opposite page).



Layers of a standard three-coat ZEU system and a PAS two-coat system. Both systems have total dry film thicknesses ranging from 9 mils to 14 mils.

A close-up view of one of the painted beam ends on the Main St. bridge project.

tional ZEU systems. In addition, the long-term corrosion resistance of PAS coatings on steel bridges has been documented to show corrosion resistance equivalent to ZEU systems.

Spanning Main Street in Maine

While PAS coatings have predominantly been used for maintenance painting on steel bridges thus far, they are starting to see more use on new steel structures. One of these is bridge #5160, which carries Main St. over the Little Madawaska River in Stockholm, Maine, and was recently replaced with a new steel crossing (designed by HNTB and fabricated and detailed by NSBA member and AISC certified fabricator High Steel Structures). The design for the replacement structure is a simple-span bridge using four steel girders and spanning roughly 100 ft. The bridge was constructed with weathering steel girders with painted beam ends approximately 5 ft from both abutments. While the coating system was initially planned to be ZEU, the Maine DOT showed interest in PAS coatings after successfully using the technology for field maintenance painting, and as a result allowed a change order for the

A Michigan DOT project—West Road over I-75 in Woodhaven, Mich.—was repainted with a PAS system in 2017.

coating system. A two-coat system consisting of an organic zinc-rich primer with a PAS topcoat was eventually specified.

Beam ends were blasted to SSPC-SP 10 prior to primer application. Following surface preparation, the zinc-rich primer was applied per manufacturer requirements at 3-5 mils dry film thickness. After the primer was applied and inspection was complete, the PAS finish coat was applied using a single-component airless pump. The final inspection on the finish coat began four hours after completion of the application. After final inspection, the beams were loaded and moved outside to the lay-down yard. The total cycle time for blasting, painting and moving the finished product outside was 36 hours.

In order to provide a comparison between the two-coat PAS system and the traditional ZEU, a second timeline was put forward based on years of experience with ZEU systems. Both timelines assume the paint bay has three shifts. The total cycle time for the ZEU system for the same beam end project would be 58 hours (see Figure 1 on p. 40 for a graphical comparison of the time cycles between the PAS and ZEU systems). This timeline for the ZEU system also assumes ideal environmental conditions (temperature and humidity). Using the two-coat PAS system reduced the cycle time by 22 hours compared to the ZEU system. This 61% increase in throughput is attributed to reduced curing time and one less coating layer. The PAS system has a combined approximately six hours of curing "downtime" while ZEU has around 26 hours of curing downtime. One less layer for the PAS system also requires one less inspection, saving an additional two hours or so of cycle time. The PAS systems enables a significant improvement in the throughput and painting efficiency of the paint shop, essentially increasing a fabricator's painting capacity without having to add additional shop space or resources. In periods of high demand, PAS coatings can improve scheduling as well as require less painting work to be subcontracted out to third parties.

Reducing the number of paint layers improves the throughput and also generates cost savings through a reduction in coating application and steel handling costs in the painting process. While the material cost of a PAS system can be double that of a ZEU system, coating application and handling costs can be greatly reduced since, again, only two layers need to be applied versus three. In the case of the Maine project, the PAS system generated a 28% savings in coating application and steel handing in the painting operations. Considering both raw material cost increase and the coating application and steel handling savings, the PAS system created an overall cost reduction for painting of 14%, which factored to a 2% reduction in the total cost of the new fabricated and painted steel girders.

As the trend to shop-apply all coats of paint for new steel bridges continues, PAS coatings offer an option to deliver significant value to both fabricators and bridge owners requiring shop painting of new steel bridges. By reducing cycle time using PAS, steel bridge fabricators can gain additional painting capacity, and this can be very significant in periods of high painting demand. Ultimately, this will lead to time and cost savings for owners who can leverage the advantages of PAS systems into solutions for new steel bridges without having to sacrifice long-term corrosion resistance. ■

This article is a summary of Session B25 "Advanced Coating Systems" from the 2018 NASCC: The Steel Conference/World Steel Bridge Symposium in Baltimore. Next year's conference takes place April 3-5 in St. Louis. Learn more at ***www.aisc.org/nascc****.*

A Connecticut DOT project—I-75 over Starr Ave. in Danbury—was repainted in 2002 with a PAS system. After 15 years in service, minimal rust has been experienced.