Rapid Deployment® – The Next Step

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Cleaning and painting of structural steel overpass bridges in heavily traveled urban corridors has long been a challenge. In addition, complex regulatory requirements applicable to abrasive blast cleaning, painting lead-based paint abatement have dramatically altered how field painting of bridge structures is conducted. Traditional methods used to prepare the surface, contain the debris, and carry out the painting require the contractor to close one or more lanes of traffic while equipment and personnel are deployed.

Traffic Disruption – The Big Issue and a Major Headache

It is not uncommon for each lane of traffic to be closed for several days while the contractor prepares the surfaces and paints the bridge structure above the roadway. This is particularly troublesome in densely populated, heavily traveled, metropolitan areas where lane closures can lead to significant traffic delays and even traffic gridlock. The traditional approach to steel bridge overpass painting involves a three-day process with the attendant traffic problems.

A New Approach – A Change in Paradigm

A technique is required to minimize the impact of the field painting operations on the traveling public, yet still safely contain the debris and overspray generated during protection. By limiting the number and duration of lane closures, and restricting work to off-peak hours, the impact on the public can be minimized, and traffic safety on the highway improved. Recent developments in coatings technology combined with the integration of state-of-the-art mobile containment platforms and a complete specification now allow for rapid mobilization into and out of lane closures areas. This technology, dubbed "Rapid Deployment,"® allows the complete removal of existing paint by open nozzle abrasive blast cleaning in full compliance with environmental regulations, followed by the application of a two coat, high build, high-performance paint system, while fully containing all debris. All this can be carried out in one shift, with a one-night closure per lane of traffic.

The Rapid Deployment® concept was developed by coatings specialist KTA-Tator, Inc. (KTA) and resin manufacturer Bayer Corporation. KTA was aware that while containment technology would soon be sufficiently advanced to allow a rapid approach to repainting, paint technological advances were needed. KTA approached Bayer to find out whether a coating system could be developed to fit the tight performance profile needed. The Bayer team developed a zinc-rich/polyurethane primer and a high build, fast drying, two-component polyurea polymer topcoat. The new topcoat was identified as "polyaspartic."

Early Experiences

The new approach (mobile containment plus the new coating system) was first put to the test on two Pennsylvania Turnpike Commission (PTC) bridges in 1998, followed by a further six bridges in 2000; nine additional bridges were painted in 2001. Two Ohio Department of

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Transportation (ODOT) bridges were also painted in 1999. The work was completed within planned time limitations, and Rapid Deployment® achieved its expectations. Some lessons were learned regarding operating details. Additional successful projects in Maryland and Virginia were undertaken as well.

The Sequence of Operations

The key difference with the Rapid Deployment® approach is that all blast cleaning and painting equipment is mobile and capable of being placed on and removed from the roadway quickly. On both the PTC and ODOT projects, the process involved closure of the traffic lane at 7 p.m.; equipment was deployed and containment sealed to allow cleaning to start by about 9 p.m. and be completed by midnight. Following removal of blast cleaning waste debris, the entire two coat, high-build paint system was applied. After a short cure-time delay, the equipment was removed from the roadway and the lane reopened to traffic by early morning. On some bridge sections, the lane was reopened ahead of schedule.

The Old Way

In contrast, traditional techniques for complete removal and repainting of structural steel overpass bridges, using the popular three-coat inorganic or organic zinc-rich/epoxy/polyurethane paint system require, at a minimum, a three-day lane closure. In this traditional scenario, the bridge is abrasive blast cleaned and prime coated the first day, the intermediate coat is applied the second day, and the finish coat is applied on the third day.

A Comparison

The new system offers significant savings in time because all work is scheduled and completed with a single lane closure during off-peak traffic hours. In addition to allowing traffic unimpeded access, this method means that the contractor benefits from improved safety, since lane closures per move are reduced from three days to one night. Although per hour labor costs may increase a bit due to slightly higher hourly rates for night work, these wage costs are more than offset by improved production rates and reduced costs for maintenance and protection of traffic and containment.

The success of the technique can be measured by the ability to complete the work on the steel above one lane of traffic, in a single work shift, with a single lane closure. In the lessons learned area, in order to achieve this, equipment must be custom tailored for the job, the coating system must be capable of meeting demanding performance requirements and application limitations, the contractor must understand the scope of his work, and quality control measures must be effective. Mobilization access and an off shift equipment storage site must be proximate to the job site. It is crucial to have a tight job specification that describes the owner's project performance requirements.

Rapid Deployment®

Because Rapid Deployment® involves the use of both a new/improved coatings technology and revised equipment use, it is important that all parties involved in the project thoroughly understand all that is to be accomplished in such a short time. The specification must clearly state the performance requirements of the work in terms that the contractor can quantify: time allowed per lane, surface preparation, containment, air monitoring, number and thickness of coating layers, hours during which operations are allowed, and so on.

The work platform must: provide easy access to the bridge structure, contain and collect all debris and overspray, provide adequate ventilation for the workers, allow for abrasive recycling, and most importantly, it must be mobile.

The moisture-cured polyurethane zinc-rich primer and polyaspartic topcoat paint system specifically developed for this new technique must be forgiving of variations in application and environmental condition. Because only two coats are being applied (coverage is crucial), the specification includes a requirement for stripe coating. This is a critical aspect because this measure prevents the early breakdown of the coating system in hard-to-coat areas such as welds, edges, fasteners, and crevices. Stripe coating assures that adequate thickness is attained and that holidays are minimized. This practice, plus the high-build nature of the paint system, results in performance characteristics similar or superior to the traditional three-coat system currently in use.

Contractor Participation and Training

Quality control is another important aspect of the job; the specification not only includes the normal inspection hold points commonly used in field bridge painting projects, but also includes contractor qualification. As part of the qualification process, the contractor must not only have experience painting bridges in high volume traffic locations, but must also arrange for a field demonstration and applicator training by the coating supplier in the use of the fast dry, high-build polyurethane paint system.

During the training, the coating manufacturer provides hands-on training and demonstrates proper mixing and application techniques to all contractor personnel involved in the application of these coatings, including supervisors. Certificates are then provided to contractor personnel who have demonstrated proficiency in the use of these coatings. Employees who have been specifically trained are allowed to apply products on the job.

Coating System

The coating system itself is critical to the success of Rapid Deployment®; it must be high build to provide the desired performance properties, and must dry quickly enough to apply all coats within about a two-hour window and to resist the embedment of spent abrasive particles as the containment is being removed.

The primary performance criteria for the Rapid Deployment® coatings system are:

- Application of the entire system must be carried out within a narrow window, under a range of ambient conditions (minimum 42ºF [7ºC], 60-85% relative humidity).

- The system must include a zinc-rich primer.

- The total applied dry film thickness must be comparable to the three-coat system. A target dry film thickness of 8 to 11 mils (200 to 275 microns) was established.

- The system must be suitable for application with traditional equipment such as brush, roller and airless spray, and must be easy for the applicators to use.

- The coatings, as applied, must meet all current regulations for volatile organic compounds established for industrial maintenance coatings. The US Environmental Protection Agency limit is currently 3.76 pounds per gallon (450 g/l).

- System performance must be at least equal to that of the current system(s) in use.

Although the coatings used for this technique are not completely new, meeting these requirements was not easy. Modifications were needed to achieve the higher film builds, and accelerators were, at times, needed to allow a rapid recoat under the wide range of ambient conditions specified; this required fine-tuning the coatings by the Bayer formulators. Moisture-cured urethane coatings can cure at low temperatures, but the recoat time of the moisture-cured zinc-rich primer and the dry-to-touch time of the topcoat can be extended. During the initial design phase, attention was focused on speeding up the recoat time of the moisture-cured urethane zinc-rich primer. After several adjustments, an optimum time range was determined which allowed the necessary recoat properties. Attention was then focused on the topcoat portion of the system.

One of the problems that arose out of the rapid recoating of the zinc primer was a tendency for the topcoat to bubble and pinhole due to outgassing. The problem became worse as the film thickness increased. Ultimately, the solvent and resin blends were carefully adjusted and the problem was overcome. Finally, a new generation of topcoat was developed. Bayer chemists formulated a polyaspartic material, which easily meets the performance criteria listed. The material must be able to cure quickly, roller or spray applied with airless equipment, and be able to be applied at high thicknesses (15 mils) without runs or sags. Once the basic formulations were fine-tuned and tested in the laboratory, the products were manufactured by paint companies and were applied under field conditions for selected project bridges.

Recent Experience in Connecticut

I-84 Over Star Avenue Bridge No. 1186

In 2002, Connecticut Department of Transportation (CONNDOT) was approached by A. Laugeni & Son Painting Contractors, West Haven, Connecticut (Laugeni). Laugeni requested that they be permitted to try a version of Rapid Deployment® on the first of two overpass structures they were already under contract to paint. The bridges (I-84 over Starr Avenue) were believed by the contractor to be suitable for "cutting their teeth" on the new technology. Laugeni already had virtually all of the required equipment needed to accomplish the job, but they had never used it exactly in this way. In addition, they had not used the complete coating systems recommended for Rapid Deployment®. As a result, they decided to use a variation on the coating system; an epoxy zinc-rich primer familiar to the crew, followed by the fast dry polyaspartic topcoat.

Some lessons were learned in this first outing for Rapid Deployment® by CONNDOT and Laugeni. Because application was done in the cool fall nights, the epoxy primer required an extra night to cure. As such, the contractor on-site time was extended, and the full application required two nights per lane. The contractor was very favorably impressed with the new polyaspartic topcoat because it sprayed easily, dried quickly, and built the thickness without runs and sags. The contractor said "It applies like butter."

State Route 911 Over I-84 (Bridge No. 1199)

In 2003, CONNDOT decided to conduct the ultimate Rapid Deployment experiment. In conjunction with Laugeni the State decided to have a side-by-side comparison of the cost of painting a two span bridge using Rapid Deployment® on one span and the traditional CONNDOT three-coat (zinc/epoxy/urethane) on the other span. Connecticut DOT Bridge Number 1199 was selected for the experiment. Bridge 1199 carries State Route 911 over Interstate 84. The four span bridge consists of two spans over I-84 each consisting of seven welded plate girders per span and the two approach spans have two fascia welded plate girders and five interior rolled beams. The bridge was constructed in 1962. It was originally painted with a three-coat lead based paint system applied directly to mill scale. During the past 40 years the bridge was spot repainted in 1976. Interstate 84 in Danbury is the classic example of an overpass bridge passing over a heavily traveled Interstate Highway. The west bound (WB) half of the beam bridge consists of 12,264 square feet of painted steel while the east bound (EB) half of the structure aggregates 10,535 square feet. The difference in surface area between the two overpass sections reflects the fact that the one side of the bridge is slightly longer than the other. Both halves of the bridge were repainted in 2003 by Laugeni. The three-coat system applied to the WB bridge span took 32 days for field operations while the two-coat Rapid Deployment® application on the EB lanes took only 21 days.

Table 1 gives the costs accumulated by the state of Connecticut Department of Transportation.

Table 1
Bridge #1199, SR 911 Over I-84

	Traditional Three-Coat System		Rapid Deployment Two-Coat System		Difference Savings or (expense)
	COST (12,264 SF)	$/SF	COST (10,535 SF)	$/SF	
MPT Labor	$14,622.81		$12,170.13		
Traffic Devices	98,989.00	$9.24	50,774.00	$5.97	$3.27
Containment and Equipment					
Mobilization/ Demobilization	$80,375.42	$6.55	$59,305.48	$5.63	$0.92
Abrasive Blasting	21,017.29	1.71	10,474.70	0.99	0.72
Primer coat	11,138.38	0.91	7,321.85	0.69	0.22
Intermediate coat	4,606.78	0.38	---	---	0.38
Topcoat	7,346.02	0.60	7,043.47	0.67	(0.07)
Contractor QC	669.93	0.05	471.06	0.04	0.01
Lead Health Protection	15,656.00	1.28	10,988.00	1.04	0.24
TOTAL COST – Contractor	$254,421.60	$20.72	$158,548.69	$15.03	$5.69
Inspection Cost	$24,125.00	$1.97	$18,288.00	$1.73	$0.24
Agency Admin. Cost	$6,837.00	$0.56	$4,951.00	$0.47	$0.09
Traffic Impact	$967,520.00	$78.89	$634,935.00	$60.27	$18.62

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Cost Difference Analysis

Maintenance and Protection of Traffic

Significant savings of $3.27 occur in the MPT area. MPT was the single largest item resulting in a savings.

The dramatic savings in this area is attributable to the fact that the contractor is on-site fewer days, and accordingly has less labor and equipment cost. The savings include both savings in labor and equipment.

Traffic devices include crash trucks, message boards, and even the cost of the state police officer stationed at the site to warn on-coming traffic to slow down. Naturally, fewer days on-site equate to lower traffic device rental costs.

Containment & Equipment

Mobilization/Demobilization

There's also a significant savings in the use of a mobile containment versus the cost of erecting a fixed containment on the bridges. The mobile containment is a prebuilt device mounted in a hydraulically activated box trailer. A significance savings ($0.92) accrued on the project simply due to cost difference between the two different types of containment enclosure utilized.

Mobil platform with hoppers

Fixed platform

Abrasive Blasting

One surprising savings was the dramatic drop in the cost of abrasive blast cleaning. Investigation of this cost-reduction revealed that in a fixed containment the blast operator consumes a significant amount time manipulating the blast hose and the air line to his blast hood and recovering spent abrasive. In the mobile containment, likely because the containment is smaller and because the blast operator is under time pressure, there is less time devoted to all the actions required by the blast operator in the fixed containment. Blast cleaning productivity almost doubled and concomitantly the costs are reduced from $1.71/ square-foot to $0.99/square-foot.

Mobil containment, good blast cleaning access

Vacuum spent abrasive in fixed containment

Primer and Topcoat

Application of the primer was slightly less costly due likely to the easy access provided by the mobile containment, the fast curing coating materials, and the time pressure to complete the painting. Note that topcoat application costs are slightly higher; the extra time spent assuring complete coverage is likely reflected.

Finished section

Contractor Quality Control

Contractor Quality Control costs are about the same. This indicates that the contractor has his quality control person on-site and ready to work with the crew to facilitate the application. In this situation, the contractor quality control and owner quality assurance persons work right along with the painters to assure that the surface preparation and coating application meet the specification requirements.

Blast cleaning and profile testing

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Lead Health Protection

CONNDOT has a specific worker Lead Health and Safety Program which all contractors removing lead based paint are required to observe. The savings on the Rapid Deployment® part of the job accrue because the workers are on site less days and as a consequence the worker safety and health program costs are reduced.

Summary

In summary, the side-by-side cost comparison of the application of the traditional CONNDOT three coat system compared to the two coat Rapid Deployment® approach on the same bridge, in the same season, by the same crew reflect a savings of 35% of the cost and about half the lane closure days. On this particular project a 35% savings represents a savings of $96,000.

Inspection and Administrative Cost Reduction

In addition to these contractor savings, which will, on subsequent projects, accrue to the owner, there are savings to the owner for reduced inspection expense ($1.97/square foot), less administrative costs ($0.56/square foot).

Traffic Impact

Savings also accrue to the public in the form of vastly reduced traffic delay time and expense. Using the formula developed by the Texas Transportation Institute (QUEWZ) the road user cost for I-84 using a three-coat system would be $78.89/square foot. When using the two coat RD approach, the road user cost is $60.27/square foot. The road user cost savings alone using this formula is $18.62/square foot for the value of reduced traffic delays, which affect motorist travel time, and operating costs. A savings of $18.62 on this small ~ 23,000 square foot project indicates a road user savings value of $428,000.00 simply due to the fact that the traveling motorists will not sit in traffic waiting for the roadway to open, thereby consuming time, fuel, and generating frustration and sometimes road rage.

The QUEWZ software program estimates the costs to drivers through a lane closure pattern. QUEWZ has multiple user inputs including lane capacity, reduced work zone capacity, traveling speed, percentage of trucks, and hourly volumes to make the calculation.