"COST EFFECTIVE ALTERNATIVE METHODS FOR STEEL BRIDGE PAINT SYSTEM MAINTENANCE"

CONTRACT NO. DTFH61-97-C-00026

REPORT V:
REMOVAL OF LEAD-BASED PAINT USING RECYCLABLE STEEL GRIT

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TECHNOLOGY INTRODUCTION

Abrasive blasting is one of the oldest and most popular surface preparation methods used in the bridge painting industry. Abrasive blasting uses high-pressure air to propel an abrasive to a substrate with the intent of removing any old coatings, mill scale and rust. Traditionally, once the abrasive media has been used to prepare a surface the combination of used media and paint are collected and treated as waste. Recyclable Steel Grit (RSG) blasting is very similar to expendable abrasive blasting except that instead of simply discarding the abrasive waste, it is recycled several times through specialized machinery that separates the paint, mill scale and rust from the reusable steel grit. The steel abrasive is reused until it breaks down into a sufficient size to be removed with the waste from the recycler. Most RSG equipment setups consist of a blast pot, recovery vacuum, recycler unit, and air compressor. Each piece of equipment can be purchased separately or collectively mounted on a trailer.

TECHNOLOGY DEMONSTRATION

During the course of this FHWA project, many opportunities to observe RSG presented themselves. Specifically, five maintenance painting projects were visited in an attempt to ascertain the cost associated with RSG. The projects represented five states, three equipment manufacturers, and four different contractors. All projects were for full removal of the old coating with an SSPC SP-10 Near White Metal surface preparation specified. The states represented were Maryland, Michigan, Missouri, New Jersey and Virginia. Each of the structures visited were rolled beam construction.

Maryland

A series of four bridges were blasted to an SSPC SP-10 surface preparation using RSG in the state of Maryland. Corrpro was able to collect data for the entire project. The contractor, Peter Mitchell Inc., East Petersburg, PA, used IPEC recyclable steel grit blasting equipment and used a custom-made suspended plywood platform. The operating pressure of the blast units ranged from 110-120 psi using G50/G60 mix steel grit. The contractor typically ran four blast pots with two blasters per pot. Utilizing several blasters, the contractor was able to quickly blast the structural steel.

Michigan

This project was conducted on the International Bridge connecting Sault Ste. Marie, Michigan to Sault Ste. Marie, Ontario. The work was performed on the Michigan side approach span of the bridge. The International Bridge Authority utilized in house blasters and painters to perform the maintenance work. The bridge elements blasted were typical plate girder type construction. The staging incorporated was manufactured by

Bridge Vail International and allowed for full negative pressure containment, automated recycle of the used abrasive, and no traffic control to conduct during the project. The workers utilized two Bridge Vail work stations: one for painting and one for blasting. This allowed for continuous work and facilitated in quick turn-around of the project. The blast equipment used, manufactured by Vector, allowed four blasters to work simultaneously but the blast crew only utilized three of the four available blast hoses. The operating pressure of the blast unit ranged from 110-150 psi. The size of the steel grit used was G50.

Missouri

In Cameron, Missouri, a MO Dot crew used RSG and ARK staging to perform a complete removal and repaint of an overpass bridge with lead based paint. The structure was a simple overpass bridge over Interstate 40 in a rural environment. The blasting/recycling equipment was manufactured by ECS, Inc. The model used was "System 10" and the foreman preferred to use G50 steel grit for the blasting media. The recycling equipment consisted of a recycler, two blast pots, and a diesel air compressor/generator that was mounted and transported on a truck and trailer. The RSG unit, when used with the ARK Staging system, automatically recovered and recycled the steel abrasive, filtering out the lead paint chips. The project required the surface to be cleaned to a SSPC SP-10 Near White Metal condition.

New Jersey

The project was located in Lawrenceville, NJ on an overpass carrying Rt. 206 over Interstate 295. The contractor, Anka Painting, Palisades Park, NJ, utilized two crews simultaneously to complete the blast and repaint of an overpass bridge. The contractor used two blasting/recycling rigs manufactured by ECS, Inc. One rig was the same "System 10" that was used in Missouri and the other was "System 20". The System 20 was a little more powerful and had eight filters on the recycler, whereas the System 10 had only six filters. The contractor had invested additional funds into the blasting equipment to upgrade the hydraulic motors and lines. For blast media, Anaka Painting used a blend of G30 and G40 steel grit as compared to the G50 used in Missouri. The surface preparation achieved by the blasters was SSPC SP-10.

Virginia

In Virginia, a simple overpass bridge crossing I-395 in Alexandria was blasted to a SSPC SP-10 Near White Metal surface condition using RSG. The contractor for this project was Reglas Painting Company, Inc., Baltimore, Maryland. The contractor utilized suspended corrugated steel staging that allowed for full negative pressure containment.

RESULTS

During observation, all the various crews used blasting pressures of at least 120 psi. Higher output pressures resulted in higher productivity rates, but workers reportedly

became fatigued much more quickly. Blast nozzle wear was a common reason for a drop in productivity, requiring that nozzles be replaced on a monthly basis. All crews used negative pressure containment with dust collectors. Each project entailed cleaning the steel substrate to a SSPC SP-10 "Near White Metal" level of surface preparation. The contractors all had their equipment mounted on trailers with the recycler integrated into the blasting setup. In all cases the rigs used could support up to four blasters, although most only used three of the four available blast hoses. Grit size and consumption rates varied and appear to be related. When contractors used smaller grit, productivity increased, but consumption also increased. When larger grit was used, consumption decreased, but so did productivity. G30/G40 mix had the best overall observed performance from a consumption and productivity standpoint. Productivity rates and grit size are shown in the following table.

Table 1. Productivity rates

Location	Productivity (ft^2/man-hour/nozzle)	Grit Size
Maryland	180	G50/G60
Michigan	200	G50
Missouri	170	G50
New Jersey	230	G30/G40
Virginia	170	-

The abrasive material, steel grit, has other advantages in addition to its high productivity and ability to be recycled. Due to its high hardness, steel grit produces a spark pattern that the blaster can follow. Also due to its high hardness, the steel grit breaks down less and therefore produces much less airborne dust. For this reason, RSG can be used at higher pressures without abrasive fracturing, in turn increasing productivity. The decrease in airborne dust also increases visibility thereby increasing productivity. Blasting with recyclable steel grit can achieve a production rate of 170-200 ft^2/man-hour or higher, as opposed to expendable grit, which has a production rate of about 100-120 ft^2/man-hour.

In addition, recycling results in less waste being generated and therefore less waste to dispose of. The resulting anchor profile height is dependent upon grit size, nozzle size and pressure.[1] A surface prepared using RSG will be dry and can be primed immediately after blasting and blow down are complete.

While it has its advantages, there are also disadvantages to RSG specifically, and also abrasive blasting in general. Disadvantages unique to RSG are that if blast media gets wet, steel grit will clump together in a large mass rendering it useless. Since it is very heavy, steel grit needs to be recovered by vacuum, which requires blasting operations stop periodically, therefor reducing productivity. Grit recovery can be aided with the use of automated systems such as grated flooring in conjunction with an auger to transport the grit to the vacuum recovery system. High equipment costs are another drawback of

[1]Munger, Charles G., Corrosion Prevention by Protective Coatings, national Association of Corrosion Engineers, Houston, TX, 1984.

RSG. The high initial investment involved may make some contractors wary of using RSG. In addition to high capitol costs, RSG requires additional equipment over "once through" abrasives, increasing maintenance. The additional equipment will require more time for mobilization if it is not a complete trailer mounted system.

DISCUSSION (ECONOMIC VALIDITY)

Many factors must be considered when determining the economic impact of a technology on a bridge maintenance painting project. The cost for a maintenance painting project can be broken down into 4 main areas:

I. Mobilization/Demobilization
II. Coating removal
- Productivity
- Equipment Cost
- Worker and Environment Protection
- Proper Waste Disposal

III. Painting
IV. Staging/Containment

In order to validate a technology one must first compare it to the current state of practice. The current state of practice in this industry is abrasive blasting with 'once-through' abrasive, which cleans ~ 100 ft^2/hr/blaster to an SSPC SP-10, while providing a negative pressure containment, PPE for workers, and hazardous disposal of all waste. Recyclable steel grit also requires negative pressure and PPE for workers, but reduces the amount of waste generated and therefore reduces disposal costs. This along with an increased production rate, ~ 200 ft^2/hr/blaster to SSPC SP-10, are the main advantages of using recyclable steel grit. Other advantages such as less airborne dust and a spark pattern, are directly related to the increased production rate.

To compare the two surface preparation technologies, a cost model built for this FHWA study was used. A productivity rate of 200 ft^2/hr/blaster was assumed based on actual site visits and compared with industry standards. This cost model estimated the cost of using recyclable steel grit to fully remove lead-based paint from bridges ranging in size from 5,000 ft^2 to 200,000 ft^2. The results are shown in Table 1 below.

Table 2. Costs per square foot

Structure Size (ft^2)	'Once Through' grit ($/$ft^2$)	RSG ($/$ft^2$)
5,000 ft^2	$13.18	$11.20
200,000 ft^2	$6.23	$2.86

These costs show a 15%-55% (depending on bridge size) decrease in price for recyclable steel grit compared to 'once-through' abrasive.

The cost savings realized are a direct result of two things: Reduced waste, and increased productivity. The major factor here is the reduced waste. Waste production and disposal costs are reduced by 93% using RSG as opposed to 'once-through' grit. With the increased productivity, labor costs for blasting operations are cut in half and total labor costs for the entire project are reduced up to 42%.

Analysis of the cost data shows RSG to be more the more cost-effective technology, though many contractors do not use it. This is because of the high initial cost for equipment. After speaking with multiple vendors of RSG rigs, it was found that a full RSG rig with a blast pot, recycler and vacuum unit can cost up to $250,000.

CONCLUSIONS

1. Use of RSG technology can significantly reduce the cost of painting, however it does require a high initial investment. The decreased costs for recyclable steel grit is due to three main factors. 1) The increased production rate; faster work means labor costs will go down. 2) The reduced disposal cost, due to the decrease in abrasive media being used. 3) The ability to reuse the blast media for several cycles, which reduces the abrasive media used.

2. Through discussion with experienced contractors, it has been determined that to achieve high productivity rates, output pressures of 120 psi or greater need to be maintained. Productivity is also affected by grit size, as is consumption. A mix of fine and coarse material is needed too achieve the best ratio of productivity to grit consumption.

3. Qualitatively, recognizable advantages recyclable steel grit offers over 'once-through' grit for the workers include less dust inside the containment, due to the use of less friable steel grit and the reduction in abrasive media needed, so the blaster can see the surface being blasted better. In addition, a spark pattern is produced by the grit on the steel substrate, which assists the blaster in seeing previously cleaned areas. When using recyclable steel grit, the same precautions need to be taken as with 'once-through' grit. The same PPE is required as well as full negative pressure containment, based on OSHA regulations.

4. Because its density is much higher than that of 'once through' abrasive, steel grit is more difficult to collect. The added weight of the grit increases the dead load on the bridge as well as the dead load on the containment, therefore contractors must remove the grit frequently, requiring blasting operations to stop periodically. The use of automated systems to collect spent abrasive are helpful by eliminating the need for an additional helper and minimizing down time for vacuum recovery.

5. It is necessary to point out that all the structures visited were rolled beam construction. No truss type structures were visited. This is significant because of the complexity of truss bridges and the difficulty to collect the steel grit after use. Therefore, an evaluation of recyclable steel grit may be different for truss structures.