518-1F

EVALUATION OF COMMERCIAL BLAST CLEANING SYSTEMS - FINAL REPORT

FCIP Study 1-10-79-518
"Evaluation of Commercial
Blast Cleaning Systems"

FHWA Contract DOT-FH-11-8608 T.O. No. 16

Final Report

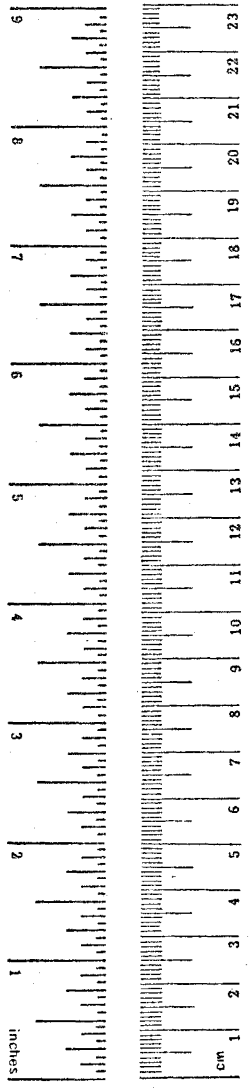
Report No. 518-1F

By
Jon P. Underwood
Senior Research Engineer
Texas State Department of Highways
and Public Transportation

METRIC CONVERSION FACTORS

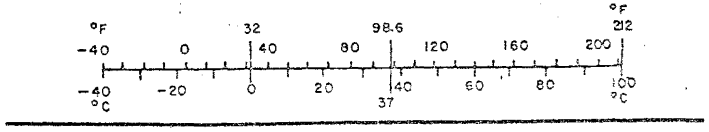
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



The objectives of this study were:

1) To evaluate two or more commercial blast cleaning systems, which could be used in a maintainance program of cleaning and painting existing steel highway bridges.

2) To determine if the systems have significant potential to reduce pollution at a reasonable cost.

The first step in completing these objectives was to determine the commercial systems available for use. The three systems chosen for evaluation in this study were:

1) Water blast with abrasive

2) Water blast without abrasive

3) Flame cleaning

All three of these were compared to dry sand blasting for speed and effectiveness in reaching the desired cleaning level.

The second step was to determine the standards for desired cleaning levels. In order to have a basis of comparison, Texas specification, "Class A Cleaning" was selected as the standard. This specification is defined as follows:

> "Class A cleaning is complete removal of all paint coatings, oil, grease, dirt, mill scale, rust, corrosion products, or any foreign matter. A maximum of 5% of each square inch of the surface may have very light shadows, very slight streaks, or slight discoloration caused by rust stain, mill scale oxide or slight stain of paint or coatings." (SSPC10).

No appendix or any other means that may add to or remove anything from the above paragraph is used.

SSPC is used to determine the maximum 5% area stated above. A tape test is used to determine if any loose material remains on the cleaned surface prior to painting. This tape test consists of sticking filament tape on the freshly cleaned surface, then removing it. If any material remains stuck to the tape, loose material remains and the steel must be re-cleaned prior to painting. The re-cleaning can be accomplished in any manner the contractor chooses.

Conventional dry sand blasting was used as the standard cleaning mode and therefore, the basis of comparison for the other three systems

The equipment used in our Dry Sand Blast Cleaning Method was as follows:

750 CFM compressor
50' of 1½" air hose
600 lb. sand pot (modified)*
Moisture trap on air supply side of sand pot.
50' of 1½" sand hose (air & sand)
20' 1" whip
#8 nozzle (½")

*Sand pot modified with a ½" pipe bypassing under the sand metering device from air to sand hose.

Field Tests

Dry Sand Blast

The cleaning rate for the dry sand blasting, with #2 sand (retained on a #16 sieve) was 345 sq. ft. per hour. At this cleaning rate the sand consumption was 2760 lbs. per hour. The normal cleaning rate for this equipment, without the sand pot modification, is approximately 300 sq. ft. per hour while using 2400 lbs. of sand.

Effective cleanup from this method of cleaning was by using the system's air pressure without the sand. One problem encountered with this cleanup method was the removal of dry sand blast sand from steel on which aluminum oxide (Black Beauty) had previously been used.

Water Blast With Abrasive

Equipment used for the water blast with abrasive portion of this experiment was:

1) Model 610-D diesel-powered 35HP, with a pumping capability of 10,000 psi at the pump,
   270 gallons of water per hour at 1800 rpm
   400 pounds of sand per hour,
2) Water discharge hose of ¼" ID
3) Sand discharge hose of 3/4" ID
4) Nozzle nZ 100 Abrasa-Blast Sand Nozzle
5) 50 pound sand blast gravity feed pot
6) Sand delivered through a venturi at the nozzle

After consultations with equipment manufactures, the above mentioned equipment was chosen, and their technical representatives were on hand to supervise the equipment usage. Based on their recommendation, the following was used: #3 sand (retained on #30 sieve) with water pressure at pump at 9500 psi, one 50' length of ¼" water hose, one 50' length of 3/4" sand hose. The sand was introduced into the flow at the 3/16" venturi type nozzle.

An anti corrosive must be used at all times during this operation. This rust inhibitor was used at the approximate rate of 3 gallons per hour and consisted of the following proportion:

5 gallon of water
1 pint of 150 isopropal alcohol
8 cups of sodium nitrate.

The necessity of using this rust inhibitor at all times is illustrated by the fact that when the suction hose was moved from one container to another the cleaned steel would flash rust in about 90 seconds.

After the cleaned surface dried, there was a heavy residue of sand on all parts of the I-beams. Attempts to clean this, using high-pressure water and rust inhibitor, only washed the sand from one I-beam to an adjacent I-beam. This problem could only be alleviated by clean up with high-pressure air.

This cleaning system could be very tiring to the workman because of the high pressures necessary to accomplish the desired cleaning rate. Additionally, an out-of-control spray nozzle could injure workmen.

This system was also evaluated on its ability to remove graffiti from concrete. Graffiti removal was successfully accomplished with no damage to concrete surfaces.

Water Blast Without Abrasive

The same equipment as the previous system was used in this evaluation with two exceptions: The abrasive induction equipment was removed and a different nozzle type was used.

Flame Cleaning

The equipment used for their system was basically the same as the excess oxygen traffic paint stripe remover used by Texas. The only modification was the removal of the carriage assembly which is normally used.

The flame and resulting air pollution caused by the burning paint could definitely be a factor affecting the health and well being of the workmen.

Results:

As stated earlier, attempts were made with all cleaning methods to arrive at the Class A cleaning level previously defined.

Of the three methods evaluated, the water blast with abrasive was the most efficient in that the cleaning rate for this system was 150 sq. ft. per hour. Water usage rate was 228 gallons per hour (1.4 gallons per square foot) with a sand usage rate of 399 pounds per hour, (2 pounds per square foot).

The next most efficient system was the water blast without abrasive. The cleaning rate for this system was 25 sq. ft. per hour at a pump pressure of 9,000 psi and a water usage of 230 gallons per hour.

The flame cleaning system was the least effective with coverage approximately the same as the water blast with abrasive. This rate of coverage was easily accomplished, but the flame cleaning did not clean the steel. Our experiences are that flame cleaning would not clean the steel at any desired rate. It cooked the old finish on the steel and blistered the paint on the opposite side of the beam. This flame-cleaned surface had to be cleaned by sand blasting before re-painting could be accomplished.

No attempts were made in this study to determine actual costs incurred as the field work for this study was performed by state maintainance forces and costs incurred would in no way compare to cleaning costs elsewhere. Cleaning rates for each system were calculated and compared to the rate for dry sand blasting to allow the user to determine representative costs and determine the appropriate cleaning system for their area. With the 345 sq. ft. per hour of cleaning with the dry sand blast system as the basis, or 100 % of desired cleaning, the following comparisons are offered:

1) Water blast with abrasive cleaning rate of 150 sq. ft. per hour or 43% of base.

2) Water blast without abrasive cleaning rate of 25 sq. ft. per hour or 7% of base.

3) Flame cleaning did not reach the desired level of cleaning so therefore, no percentage is calculated.

In order to arrive at a cleaning rate comparable to dry sand blasting, the following must be considered:

Water blast with abrasive requires 230% more man-hours, 86% less sand, 525 gallons of water, and 7 gallons of rust inhibitor.

Water blast without abrasive requires 1380% more man-hours, 100% less sand, 3174 gallons of water, and 41.4 gallons of rust inhibitor.

Conclusions and Recommendations

1) Dry sand blasting is an effective and cost beneficial cleaning system.

2) Pollution of air and water is of concern with any cleaning system, especially when operating over water.

3) The effects of pollution prevention should be seriously weighed when comparing labor intensive operations. Taxpayer's dollars are generally paying for steel cleaning operations, so therefore pollution reduction value versus added cost to taxpayers should be carefully weighed.