Cleaning Historic Concrete:

A comparison of four methods for cleaning previously-coated historic concrete as demonstrated on the South Llano Bridge in Junction, TX.

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Background

The South Llano Bridge in Junction is a historical steel truss bridge with a concrete substructure built in 1937 and currently undergoing minor repair and a full repaint.

Recoating of the steel involves removing the original lead paint system and leaded overcoat system from the steel. Standard full-containment practice using recycled steel grit blasting was chosen as the method to clean the steel and remove the leaded coatings, remove original millscale, and achieve an anchor profile on the steel.

Recoating of the concrete involves removal of the degraded original coating, removal of graffiti and patch recoating, and general cleaning of exposed concrete prior to the actual repainting.

Numerous approaches were discussed for cleaning the concrete prior to repainting. The ultimate goal of the concrete cleaning was to retain as much sound, original concrete in the original condition while still removing all existing paint (degraded original system, graffiti, patch repaint) and other contaminants such as dirt, fungus (mold/mildew) and lichens growing on the concrete.

Conventional blasting with steel grit and high pressure water blasting were discarded as being overly damaging to the concrete, so several methods were suggested for trial and evaluation: The contractor suggested conventional blasting with less aggressive grit such as coal slag or glass beads, the Texas Historical Commission suggested a peel-type chemical stripper, and I suggested several alternative blasting. Of these alternatives, dry ice blasting was selected for trial along with chemical stripper, and conventional blasting with coal slag and glass beads.

Hazardous materials (lead)

Virtually all painted steel on this bridge is painted with high-lead paint.

The underside of the concrete deck has many areas with a moderate amount of lead paint. This small amount of lead appears to be largely due to overlapping and overspray during application of the prior repaint job.

The concrete substructure was evaluated in several areas both by collection of paint chips coupled with laboratory testing by atomic absorption, and field tested with a portable XRF unit for lead. No significant lead was found anywhere on the substructure.

Evaluation

Four methods of coating removal were chosen for evaluation on the bridge substructure on December 19, 2007; conventional blasting with coal slag, conventional blasting with glass beads, chemical stripper and pelletized dry ice blasting.

Conventional blasting with coal slag

Coal slag is a brittle, somewhat hard byproduct material commonly used for abrasive blasting. Coal slag shatters on impact and usually leaves a relatively sharp (if dusty) profile on steel.

A small contained workspace was set up in advance by the contractor (Blastco), with a small plywood-contained work area, compressor, blast pot, air-fed hood, and large-volume dust collector. Blasting was performed on the concrete by one of their more experienced blasters and performed at lower pressures than the 100PSI generally used to clean steel.

Results were somewhat patchy and likely influenced by the large amount of dust generated during the blasting process. Some areas showed etching of the concrete, while others showed some remaining paint (See Appendix.)

Conventional blasting with glass beads

Glass beads are a somewhat hard material, generally produced from recycled waste glass. These glass beads are often used to clean softer metals such as aluminum and leave a relatively rounded profile on metal.

The same setup and containment area as the coal slag testing was used, with a small plywood contained area, compressor, blast pot, air-fed hood, and large-volume dust collector. Blasting was performed on the concrete by the same blaster and performed at lower pressures than the 100PSI generally used to clean steel.

Results were very similar to the coal slag blasting. Some areas showed etching of the concrete, while others showed some remaining paint (See Appendix.)

Chemical stripper

Chemical strippers are more often used in building rehabilitation projects, particularly when lead is present, and for stripping paint from the relatively thin aluminum of aircraft. These strippers often include aggressive solvents and/or high pH as the active ingredients.

The chemical stripper and paper were applied to the concrete several hours in advance of the blast trial, and were peeled off following all blasting operations. Significant residue remained on the concrete, which had to be removed with water and scrubbing. For larger areas a pressure washer could be used.

The chemical stripper only removed a small portion of the paint and would need several additional applications. There was no visible damage to the concrete (See Appendix.)

Dry ice blasting (pelletized)

Dry ice blasting is a relatively new technology compared to conventional abrasive blasting. Both shaved dry ice and pelletized dry ice are used, with the pelletized option likely offering better performance. Testing was performed with the pelletized version

A large compressor, hopper, and gun were supplied by the vendor. The only containment was a tarp on the ground.

Initial results by the vendor's representative were relatively good with no etching or damage to the concrete. Most of the paint was removed, though some horizontal lines of shadowing remained.

The operation of the dry ice setup is such that with no prior experience and roughly 10 seconds of instruction, I was able to effectively perform the dry ice blasting immediately. By experimenting and increasing standoff distance from the demonstrated 2-4" eventually to around 24", I was able to achieve both more thorough cleaning, and a faster production rate. I tried an area with little remaining paint, but significant fungus growth and lichens. These contaminants also cleaned off rapidly and thoroughly. Again, there was no detectable etching or damage to the concrete(See Appendix.)

Advantages and Disadvantages

Conventional blasting with coal slag or glass beads

Advantages:

Cheap blast media
Familiar to contractors and workers
Relatively fast

Disadvantages:

At least slightly damaging to concrete
Very skill and training intensive for the operator -poor technique will cause more concrete damage
Containment and dust collector needed
Additional personal protective equipment required (supplied air hood)
Poor visibility of surface when blasting
Large volume of waste for disposal

Chemical stripper

Advantages:

No physical etching of concrete
No containment needed

Disadvantages:

Very slow, labor-intensive, multistep process
More expensive than blasting
Can be hazardous to workers
No visibility of surface while stripping
Large volume of waste for disposal
Multiple types of waste for disposal (stripper, paper, wash water)
Possible chemical reaction with concrete

Dry ice blasting (pelletized)

Advantages:

No damage to concrete
Not skill-intensive - little training needed
Little containment needed for non-hazardous paint
Excellent visibility of surface while blasting
Very little waste for disposal
Relatively fast
Overall cost potentially similar to conventional blasting

Disadvantages:

Unfamiliar equipment
Relatively new technique
Costs not yet firm
Dry ice pellets must be sourced and stored
Confined spaces must be ventilated properly

Conclusions

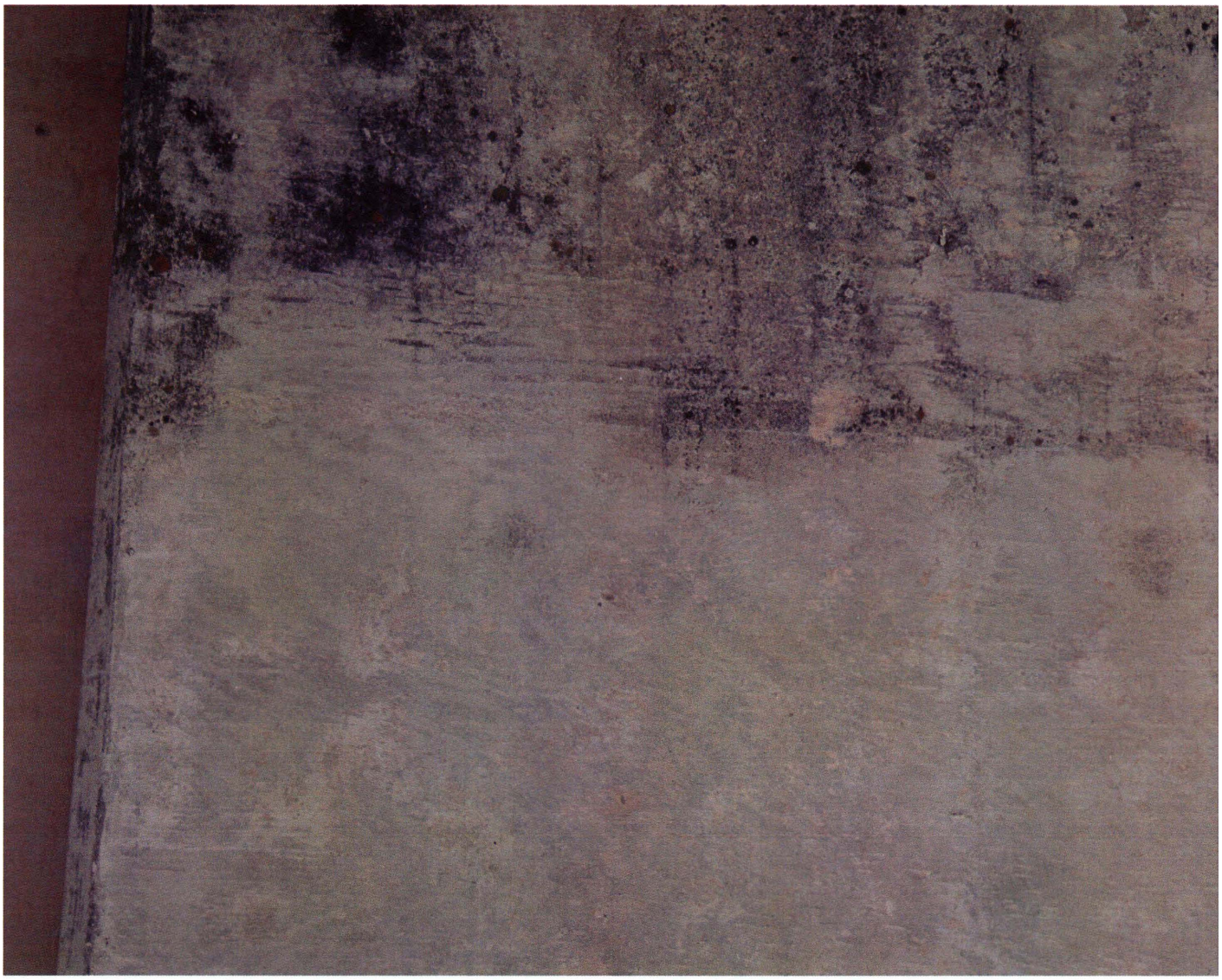
Pelletized dry ice blasting is clearly the best choice for cleaning concrete on this project, unless projected costs were significantly understated.

Pelletized dry ice blasting shows significant advantages over both conventional abrasive blasting and chemical stripper methods for historical concrete. The dry ice blasting was able to remove paint nearly as fast as conventional abrasive blasting while maintaining excellent visibility of the concrete. Unlike conventional blasting, dry ice blasting caused no etching or other damage to the concrete and is not as training or skill intensive for the operator. Unlike conventional blasting or chemical stripping, very little waste was generated.

Additionally, the South Llano Bridge in Junction would be an excellent choice for a full scale pilot project evaluation of pelletized dry ice blasting on historic concrete. This project offers a variety of different paints and contaminants for removal, ranging from fungus and very degraded 70-year-old paint to multiple thicknesses of modern paint over multiple layers of graffiti. This will allow evaluation of the method over varying surface conditions.

Appendix

Initial blasting with dry ice. Note lack of dust.



Area partially cleaned by dry ice blasting. Lower portion ready to paint.

Area partially cleaned by chemical stripper. Will require additional treatments.

Areas cleaned by abrasive blasting. Some surface damage evident.