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ACKNOWLEDGEMENTS

The author wishes to acknowledge the following for their contributions:
Rukhsana Lindsey—Director of Research, Utah Department of Transportation
Dan Betts, UDOT Region 2 Operations Supervisor
UDOT Region 2 Maintenance Forces
Robert Miles, UDOT, Standards & Pre-construction Engineer
Dry Ice Blasting Service (D.I.B.S.)
Interstate Striping Services
Dunn-Rite Lines (formerly COMAX)
Waterblasting Technologies
DLP Construction Co.
1. **Report No.**
   UT-08.12

2. **Government Accession No.**

3. **Recipient's Catalog No.**

4. **Title and Subtitle**
   FIELD COMPARISON OF FIVE PAVEMENT MARKING REMOVAL TECHNOLOGIES

5. **Report Date**
   Jan. 2009

6. **Performing Organization Code**
   N/A

7. **Author**
   Ken Berg, P.E.
   Stan Johnson, E.I.T

8. **Performing Organization Report No.**
   N/A

9. **Performing Organization Name and Address**
   Utah Department of Transportation
   4501 South 2700 West
   Salt Lake City, Utah 84114-8410

10. **Work Unit No.**
    N/A

11. **Contract or Grant No.**
    N/A

12. **Sponsoring Agency Name and Address**
    Utah Department of Transportation
    4501 South 2700 West
    Salt Lake City, Utah 84114-8410

13. **Type of Report & Period Covered**
    FINAL

14. **Sponsoring Agency Code**

15. **Supplementary Notes**
    Prepared by the Utah Department of Transportation

16. **Abstract**
    This paper reports on the effectiveness of five different methods of pavement marking removal, including diamond grinding, carbide grinding, hydraulic blasting, dry ice blasting, and soda blasting. The measures of effectiveness used were a quantitative measure of speed of removal and a subjective discussion of surface preparation and the pros and cons of each technology.

17. **Key Words**
    Pavement marking removal

18. **Distribution Statement**
    UDOT Research Division
    4501 South 2700 West-box 148410
    Salt Lake City, Utah 84114

19. **Security Classification**
    (of this report)
    Unclassified

20. **Security Classification**
    (of this page)
    Unclassified

21. **No. Of Pages**
    27

22. **Price**
    N/A

23. **Registrant's Seal**
    N/A
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EXECUTIVE SUMMARY

A demonstration of five different pavement marking removal systems was presented in May of 2008. The five methods were diamond grinding, carbide grinding, hydraulic blasting, dry ice blasting, and soda blasting. Each of the technologies was applied to sections of chip seal pavement, and Portland cement concrete (PCC) pavement.

The two grinding technologies are still the most effective in removing lines quickly and providing a clean, prepared surface for marking installation. The soda and dry ice technologies should be investigated for possible use where space is limited or other specialized removal needs are present, but are not yet comparable to the production rates of the grinding or water blasting equipment. The amount of dust generated by the soda blasting technique should be factored into a manager’s decision to use that technology.

The water blasting technology is the most effective at marking removal with the least amount of damage to the pavement and should be investigated for possible use by the Department.
1.0 INTRODUCTION

Representatives from UDOT, FHWA Utah Division Office, Salt Lake County, Salt Lake City and the Airport Authority were in attendance.

2.0 RESEARCH METHODS

The objectives of the test were to compare the effectiveness of the removal technologies and the relative visibility of the remaining shadow lines.

Personnel from the Research Division of the Utah Department of Transportation (UDOT) attended the demonstration and video recorded the processes and measured the removal times.

3.0 APPLICATION OF TECHNOLOGIES

The five technologies used are as follows:
Each of the technologies was used on a selected stretch of chip sealed pavement, and then on a selected stretch of Portland Cement Concrete (PCC) pavement.

The vehicle-borne technologies (grinding and hydraulic blasting) were tested on 650’ sections of pavement that were marked with two-year old, white waterborne shoulder paint placed on a chip seal. On concrete, the test section was a 300’ stretch of waterborne paint placed over the top of existing white, epoxy shoulder paint.

The blasting technologies (dry ice and soda) were tested on fifty-foot sections of the same pavement on which the vehicle-borne technologies were applied.

4.0 DATA COLLECTION

Quantitative data included the length of pavement marking removed per unit time, and the depth and width of marking removal when used on chip seal.

The qualitative data collected is in the form of images that were exported from the video.

4.1 Quantitative data

Table 1 summarizes the speed of each of the 5 removal technologies, in descending order, on the chip seal surface. The tests on chip seal were conducted on the north bound shoulder of SR-202. The tests on concrete were conducted on the eastbound off-ramp of I-80 as it turns onto SB SR-202. Both locations were tested on 5/6/08.

On 6/23/08 the soda blasting technology on the chip sealed surface was tested on the north bound shoulder of SR-202 using three separate nozzles. The tests on concrete were conducted on the I-80 west bound on ramp at the 7200 South interchange using only one nozzle.
### Removal Rates on Chip Seal

<table>
<thead>
<tr>
<th>Process</th>
<th>Depth Setting</th>
<th>Head Width (in.)</th>
<th>Head Type</th>
<th>Distance (ft.)</th>
<th>Time (sec.)</th>
<th>Ave. Speed (ft./sec.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbide Grind</td>
<td>20 mils</td>
<td>6</td>
<td>Grinding heads</td>
<td>650</td>
<td>295</td>
<td>2.20</td>
</tr>
<tr>
<td>Diamond Grind</td>
<td>20 mils</td>
<td>5.5</td>
<td>Grinding heads</td>
<td>650</td>
<td>336</td>
<td>1.93</td>
</tr>
<tr>
<td>Hydro Blast</td>
<td>none, floats on surface</td>
<td>12</td>
<td>Blasting head</td>
<td>650</td>
<td>356</td>
<td>1.83</td>
</tr>
<tr>
<td>Soda Blast-3rd</td>
<td>none, held above surface</td>
<td>12</td>
<td>Hand-held wand</td>
<td>300</td>
<td>222</td>
<td>1.35</td>
</tr>
<tr>
<td>Soda Blast-2nd</td>
<td>none, held above surface</td>
<td>n/a</td>
<td>Hand-held wand</td>
<td>300</td>
<td>313</td>
<td>0.96</td>
</tr>
<tr>
<td>Soda Blast-1st</td>
<td>none, held above surface</td>
<td>n/a</td>
<td>Hand-held wand</td>
<td>300</td>
<td>399</td>
<td>0.75</td>
</tr>
<tr>
<td>CO₂ Blast</td>
<td>none, held above surface</td>
<td>n/a</td>
<td>Hand-held wand</td>
<td>4</td>
<td>240</td>
<td>0.02</td>
</tr>
</tbody>
</table>

(Table 1) Removal rates on chip seal, fastest to slowest, in descending order

### Removal Rates on Concrete

<table>
<thead>
<tr>
<th>Process</th>
<th>Depth Setting</th>
<th>Head Width (in.)</th>
<th>Head Type</th>
<th>Distance (ft.)</th>
<th>Time (sec.)</th>
<th>Ave. Speed (ft./sec.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbide Grind</td>
<td>20 mils</td>
<td>6</td>
<td>Grinding heads</td>
<td>300</td>
<td>222</td>
<td>1.35</td>
</tr>
<tr>
<td>Diamond Grind</td>
<td>20 mils</td>
<td>5.5</td>
<td>Grinding heads</td>
<td>300</td>
<td>313</td>
<td>0.96</td>
</tr>
<tr>
<td>Hydro Blast</td>
<td>none, floats on surface</td>
<td>12</td>
<td>Blasting head</td>
<td>300</td>
<td>399</td>
<td>0.75</td>
</tr>
<tr>
<td>Soda Blast</td>
<td>none, held above surface</td>
<td>n/a</td>
<td>Hand-held wand</td>
<td>8.66</td>
<td>372</td>
<td>0.02</td>
</tr>
<tr>
<td>CO₂ Blast</td>
<td>none, held above surface</td>
<td>n/a</td>
<td>Hand-held wand</td>
<td>1.33</td>
<td>120</td>
<td></td>
</tr>
</tbody>
</table>

(Table 2) Removal rates on concrete, fastest to slowest in descending order

#### 4.2 Visual data

Below is the visual data gathered:
4.2.1 Dry ice Blasting

(Figure 2) Results of dry ice blasting on chip seal using a hand-held wand (note the marking material is completely removed but the surface is pitted. The dry ice dissipated into the air leaving no residuals.)

(Figure 3) Results of dry ice blasting technique on concrete (note the marking material is completely removed and the surface is free from pitting with a faint shadow line.)
4.2.2 Carbide Grinding

(Figure 4) Results of carbide grinding technique on chip seal (note the marking material is completely removed but a shadow line still remains)

(Figure 5) Results of carbide grinding technique on concrete (note the marking material is partially removed and a shadow line still remains)
4.2.3 Diamond Bit Grinding

(Figure 6) Results of diamond grinding technique on chip seal (note the marking material is removed and a shadow line remains)

(Figure 7) Results of diamond bit grinding technique on concrete (note the marking material is removed and a shadow line remains)
4.2.4 Hydraulic blasting

(Figure 8) Results of hydraulic blasting on chip seal while still wet.

(Figure 9) Results of hydraulic blasting on chip seal after drying. Note a shadow line still remains and the material is completely removed.
(Figure 9) Results of hydroblaster technique on concrete while still partially wet. Note the marking material is completely removed and a shadow line still remains)
4.2.5 Soda Blasting

(Figure 10) Bicarbonate blasting technique on chip seal. Note the residual dust created during the blasting process.
(Figure 11) Results of soda blasting technique on chip seal. Note marking material seems completely removed and a shadow line still remains. Note, also, the residual dust on the road surface.

(Figure 12) Results of soda blasting technique on concrete. Note the marking seems completely removed and a faint shadow line still remains. Note, also, the residual dust on the road surface.

5.0 DATA EVALUATION/ANALYSIS

Data was compared in both quantitative and qualitative terms. The simplest comparison was the amount of pavement marking removed per unit time. The quantitative data factored in appearance of finished product, the effect a given technology had on the pavement (e.g. pavement was left wet, pavement was degraded, etc.), and other concerns that might arise through use of the technology (e.g. the generation of dust that obscures the road at the site).

6.0 CONCLUSIONS

Given that the data was both qualitative and quantitative, data evaluation will be presented as a series of “pros” and “cons” with regards to the individual technologies.
6.1.1 Dry Ice Blasting

“Pros”: Dry ice blasting does not create environmental concerns. Pavement degradation on concrete was lower than any of the vehicle-mounted technologies, and the technique left no “shadow lines”.

“Cons”: Dry ice blasting had one of the lowest distance/time removal rates of the five technologies (averaging .015 feet/second). The technology also generated considerable noise and pitted the chip seal surface.

6.1.2 Carbide Grinding

“Pros”: Removal speed of the pavement marking was the highest of the tested technologies. The surface was clean, dry, and ready for repainting immediately following grinding.

“Cons”: Carbide grinding degraded the pavement during the grinding process. The grinding also left “shadow” lines, which were still visible particularly on PCC pavement.

6.1.3 Diamond Bit (COMAX) Grinding

“Pros”: Removal speed of the pavement marking was comparable to carbide grinding. The surface was clean, dry, and ready for repainting immediately following grinding.

“Cons”: Diamond grinding degraded the pavement during the grinding process. The grinding also left “shadow” lines, which were still visible, particularly on PCC pavement.

6.1.4 Stripe Hog Hydroblaster

“Pros”: Removal speed of the pavement marking was comparable to carbide grinding. The Stripe Hog left no shadow lines, and caused less pavement degradation than the two grinding methods that were tested.

“Cons”: The scoured surface remained wet for some time after the pavement marking removal. This could be a particular concern during periods of lower temperatures, when they drying time would increase.

6.1.5 Soda Blasting

“Pros”: Pavement degradation was lower than any of the vehicle-mounted technologies, and the technique left no “shadow lines.”
“Cons”: Soda blasting had one of the lowest distance/time removal rates of the five technologies (ranging from .08 ft./sec to .14 ft./sec). The technology also generates dust, which can be a potential safety hazard by lowering the visibility at the work site.

7.0 RECOMMENDATIONS/IMPLEMENTATIONS

The two grinding technologies are still the most effective in removing lines quickly and providing a clean, prepared surface for marking installation. The soda and dry ice technologies should be investigated for possible use where space is limited or other specialized removal needs are present, but are not yet comparable to the production rates of the grinding or water blasting equipment. The amount of dust generated by the soda blasting technique should be factored into a manager’s decision to use that technology.

The water blasting technology is the most effective at marking removal with the least amount of damage to the pavement and should be investigated for possible use by the Department.
APPENDIX A
Technology: Diamond Grinding
Contractor: Dunn-Rite Lines (formerly Comax)

(contact information not available at the time of this writing)
APPENDIX B

Technology: Carbide Grinding
Contractor: Interstate Barricades
           858 McCormick
           Layton, UT 84041-7200
           (801) 546-0220
APPENDIX C
Technology: Hydraulic Blasting
Vendor: Waterblasting Technologies
3321 SE Slater Street
Stuart, FL 34997
(877) 964-7312 Toll-Free
www.waterblastingtechnologies.com
APPENDIX D

Technology: Dry ice

Dry Ice Blasting Service (DIBS)
2217 Cahabra Dr. Birmingham, AL
205-995-2412
APPENDIX E
Technology:  Soda Blasting
Contractor:  DLP Construction Co.
    Doug Parker
    2927 W. 10400 S.
    South Jordan, UT  84095
    801-446-0890 Office
    801-301-3054 Cell
TECHNICAL SPECIFICATIONS

Chemical name: Kieserite
Bulk Density: 90 lbs./cu. ft.
Specific Gravity: 2.6
Color: Almost White
pH: 7.0
Hardness: 3.5 Mohs
Size Range:
- COARSE
  - 20-40 Mesh
- MEDIUM
  - 40-60 Mesh
- FINE
  - 64-80 Mesh

Environmentally Sound
- Water soluble, non-toxic, neutral pH
- Will not corrode copper, brass or aluminum substrates
- Easy clean-up; will not harm foliage or microorganisms present for remediation
- Will not damage or kill foliage or vegetation

Worker Safety in Mind
- No solvents, caustic chemicals or free silica hazards in MaxxStrip Blast Media
- Non-sparking, no explosive environment from airborne dust

Safe For Process Areas
- Will not damage mechanical seals or bearings in rotating equipment
- Removes mill scale and medium to heavy rust scale
- Exceptionally useful in tube cleaning and fin fan units

Effective and Quick
- Available in 3 mesh ranges for a variety of substrates
- Will not corrode aluminum jacketing, damage brass or copper electrical contact closures
- Can remove coatings, grease, rust or almost any foulant without having to shut down process streams

Benefits of water solubility with higher production rates than other water soluble abrasives

For technical sales and service:
Universal Minerals, Inc.

www.watersolubleabrasive.com
MATERIAL SAFETY DATA SHEET

GENERAL INFORMATION

Manufacturer: Universal Minerals, Inc.
6319 Brookhill Drive
Houston, Texas 77087
713.797.0054 Phone
713.797.1014 Fax

Creation Date: 07/00

I. PRODUCT IDENTIFICATION

Trade Name: MAXXSTRIP BLAST MEDIA
Formula: Kieserite Blended Formulation
CAS No.: 7487-88-9
Shipping Name: Maxxstrip Blast Media (Not restricted article) D.O.T.
Maxxstrip Blast Media (Not restricted article) I.A.T.A

II. INGREDIENTS

Non Hazardous: 100%
Hazardous: None

III. PHYSICAL DATA

Bulk Density: 2.6 g/ cm³
Odor: Odorless
Appearance: Almost white
Solubility in H₂O: Yes
pH (1% solution): 7.0
Melting Point: 1,130° C
**Mineral Name:** Kieserite

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<th>Chemistry (Dry Basis)</th>
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<td>S</td>
<td>23.0 %</td>
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<tr>
<td>Cl</td>
<td>0.2 %</td>
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<tr>
<td>MgSO₄</td>
<td>82.4 %</td>
</tr>
<tr>
<td>CaSO₄</td>
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<tr>
<td>K₂SO₄</td>
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</tr>
<tr>
<td>KCl</td>
<td>0.3 %</td>
</tr>
<tr>
<td>NaCl₂</td>
<td>0.2 %</td>
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<tr>
<td>MgCl₂</td>
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<td>H₂O ges.</td>
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**PH:** 7.0  
**Water Soluble:**  
**Mohs Hardness:** 3.5

**Size Range**

<table>
<thead>
<tr>
<th>Coarse</th>
<th>Medium</th>
<th>Fine</th>
</tr>
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<tbody>
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<td>20-40 Mesh</td>
<td>40-60 Mesh</td>
<td>60-80 Mesh</td>
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