

## Vortex Drying System



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## Moisture Content Testing in Concrete & Asphalt

**Purpose:** The purpose of this experiment was to determine the amount of time necessary for any moisture, introduced by the Stripe Hog Systems' marking removal method, to dissipate from concrete & asphalt surfaces. To accomplish this task, we conducted a series of thorough tests for our client, Waterblasting.com. We utilized an extensive inventory of moisture meters and other related equipment to positively identify the amount of time necessary for the blasted surfaces to return to the same moisture content as the adjacent unblasted, unaffected areas. (equilibrium moisture content). Our client was utilizing the Stripe Hog, Stripe Removal System operating at 40,000 psi and a flow rate of 6 gallons per minute. This system also features a high powered vacuum system also manufactured by our client to remove the water used and any debris or material generated. The system is designed to remove markings from roads and runway surfaces and leave the surface in a clean and almost dry condition. This series of tests were conducted at McGee Tyson Airport (Knoxville, TN).

### Tools & Meters:

Protimeter Moisture Measurement System  
Protimeter Surveymaster (penetrating & non-penetrating)  
Protimeter hammer Probe  
Delmhorst BD-10  
Delmhorst BD-2100  
Delmhorst hammer Probe  
Tramex non-penetrating meter  
Raytek Ranger (model 5) infrared temperature gun  
Vaisala HM-34 thermo-hygrometer  
Vaisala HMI-41 thermo-hygrometer  
Systems infrared camera

### Outside Ambient Conditions:

Partly Cloudy  
84°F / 42% = 76 grains of moisture  
These conditions are great for this test because

they are very average. This gives us good baseline readings.

Concrete & Asphalt = about 22 inches thick

**Unaffected Concrete & Asphalt:  
(target moisture content)**

**Non Painted Section**

Temperature - 100.5°F  
Moisture Content  
Average - 19-20%  
Grains of moisture  
(cup) - 65 gpp

**Painted Section**

Temperature - 99 ° F  
Moisture Content  
Average - 19-20%  
Grains of moisture  
(cup) - 65 gpp

**Wet Concrete (with a cup of water):**

Temperature of the concrete = 92°F

For the purpose of this report, “the affected areas” shall in all cases refer to areas passed over with the Stripe Hog, Stripe Removal System. Our first step was to take relevant readings from three unaffected areas, added those numbers together and divided by three. This provided us with the average moisture content of unaffected areas. The goal was then to discover the amount of time necessary for each affected area to return to the unaffected average.

### **Section 1**

The first affected section we measured had been passed over with the Stripe Hog System 20 minutes prior to conducting the following tests.

- Using a combination of 3 different non-penetrating meters we got an average of 17-19% moisture content. This means that at least the top 3/4” was already dry.
- The temperature of the affected area was 99.7° F, which is actually higher than the unaffected painted surfaces. This illustrates that the affected area is definitely dry. When a material is wet, it will have a cooler temperature than other areas (dry) around it. This is due to the cooling affect on the material caused by evaporation. Evaporated water removes energy & heat (sensible as well as latent heat) from the material which lowers the temperature. This higher temperature reading was also owing in part to the fact that when the concrete was water blasted, the machine removed the markings, dirt and residues brought on by the long exposure to the outside conditions. This resulted in a higher percentage of the suns energy being absorbed by the concrete, allowing it to dry very quickly & thus resulting in a lower moisture content percentage and a higher temperature.

- A cup was sealed on top of the affected area & allowed to acclimate for about 1 hour. This test was carried out to find out the rate of evaporation or the amount of evaporation from the concrete. A thermo-hygrometer was placed through a hole in the top of the cup & again was given time to acclimate. We then calculated the grains of moisture inside the cup. This was then compared to the same test on an unaffected area. In both cases, the grains of moisture were 65. If the surface had retained moisture from the blasting operation, then the grains of moisture in the affected area would have been higher than the grains in the unaffected cup.
- The affected area was then tested with a penetrating hammer probe up to 1.5" in depth. At 1.5", the moisture content was 31%. This was the same reading as the unaffected area.
- The last test was done at 2.5" in the affected area. The moisture content was 45% according to the Protimeter Surveymaster Hammer Probe, which measured exactly the same as the unaffected area at the same depth.

### **Section 2**

The second affected section we measured had been passed over with the Stripe Hog System 5 minutes prior to conducting the following tests.

- The average moisture content of this section was 21-26%, which was notably above the unaffected average of 19% - 20%. This shows that a portion of the introduced moisture had not yet dissipated.
- The temperature of the affected area was 97°F. This 2 degree drop from the unaffected average is because it is still wet and is experiencing the cooling effect of evaporation.
- The grains of moisture in the cup of the affected area were 95 compared to the 65 grains of moisture per pound in the cup of the unaffected area further illustrating the introduced moisture still present.
- At 1.5" in depth, the moisture content was 45%. This was well above the 31% measured in the unaffected area.
- At 2.5" in depth, the moisture content was 99% again well above the 45% average in the unaffected areas.(both according to the Protimeter Surveymaster hammer probe)

### **Section 3**

The third affected section we measured had been passed over with the Stripe Hog System 4 hours prior to conducting the following tests.

- These readings were identical to the readings of Section 1. (Both were dry)

The previous 3 sections were tested on concrete and can be referenced in the following table.

	<b>Time after Stripe Hog blasting</b>	<b>Average % of Moisture Content</b>	<b>Temperature of the concrete surface</b>	<b>Grains of moisture (cup)</b>	<b>Probe Moisture Meter 1.5" depth</b>	<b>Probe Moisture Meter 2.5" depth</b>

<b>Unaffected Non Painted</b>	n/a	19-20%	100.5°F	65	31%	45%
<b>Unaffected Painted</b>	n/a	19-20%	99°F	65	31%	45%
<b>Wet Concrete</b>	n/a	65%	92°F	115	n/a	n/a
<b>Section 1</b>	20 Minutes	17-19%	99.7°F	65	31%	45%
<b>Section 2</b>	5 Minutes	21-26%	97°F	95	45%	99%
<b>Section 3</b>	4 hours	17-19%	99.7°F	65	31%	45%

We carried out the following separate tests on an asphalt section of the runway.

### Section 4 (asphalt)

The first affected Asphalt section we measured had been passed over with the Stripe Hog System 25 minutes prior to conducting the following tests.

- The non-penetrating meters showed the top of the asphalt's moisture content to be 14% on the affected area. The unaffected test was measured at 15%.
- The temperature of the affected area was 113°F compared to the unaffected temperature of 111°F.
- There are reasons the affected area moisture content measured less than the unaffected, and the temperature of the affected area was higher than the unaffected area. This was due to the fact that when the asphalt was water blasted the machine removed the dirt and residues brought on by the long exposure to the outside conditions. This resulted in a higher percentage of the sun's energy being absorbed by the asphalt, allowing it to dry very quickly & thus resulting in a lower moisture content percentage and a higher temperature.
- The moisture content was tested at 1.5" in the affected area. It was 17% compared to the 19% moisture content reading of the unaffected area. This is again due to the removal of the dirt and residues.
- The thermal imaging camera showed no significant contrast in color. Actually, the affected area had a brighter color than the unaffected area. This means that the affected area was actually dryer than the unaffected area

Following is a chart to reference for the Asphalt Testing

	<b>Time past the Stripe Hog blasting</b>	<b>Average % of Moisture Content</b>	<b>Temperature of the concrete surface</b>	<b>Probe Moisture Meter 1.5" depth</b>
<b>Unaffected</b>	n/a	15%	111 F	19%
<b>Section 4</b>	25 Minutes	14%	113 F	17%

### Conclusions

One important fact to discuss is that the moisture content numbers in this report are not exact or true moisture content readings **as a percentage**. The definition of moisture content is simply the water weight as a percentage of a material, compared to an oven dried sample of that same material. So if you have a piece of wood that is 10 lbs & its moisture content is 10%, this means that 1 lb of the total weight is actually water. The reason the moisture content readings are not exact for the concrete in this experiment or any experiment is because all moisture meters available are based on kiln dried wood and nothing else. This means they only give true moisture content percentage readings for kiln dried wood & nothing else. Every other material is given as only a relative percentage. Even though we can confidently describe the state of the concrete & asphalt as far as the moisture it contains, this is done by comparing unaffected sections of concrete & asphalt to affected areas. We have also taken the average moisture readings from several different types of moisture meters listed in this report. Our firm has carried out thousands of previous tests on every material imaginable, including concrete & asphalt. The unaffected area tests provide the baseline and represent what the affected areas need to be dried back to. This is regardless of whether it is a true relative moisture weight percentage reading.

Now that this point has been made, here is a summary that the results of these tests conclusively demonstrate. Our client retained us to conduct these tests because there have been persons or entities suggest that the Stripe Hogs' introduction of water onto the road surface makes that surface unacceptable for reapplication of new markings for an unacceptable length of time. Although the many advantages of the Stripe Hogs' removal method are quite convincing, the mere fact that the Stripe Hog uses water to remove the markings has been the subject of discussion and questioning. One specific specification by a material manufacturer states that the applicator must wait 24 hrs after "any measurable moisture" has fallen, prior to applying its road markings. This spec is completely absurd given the fact that dew, which is substantial moisture and is certainly measurable, falls once every 24 hrs and falls over a period of hours. This would effectively mean that the manufacturers' marking materials could never be applied according to spec. We have encouraged our client to seek specific measurable moisture content, in a numbers form, that would be allowable by the manufacturers or inspectors as this would be a verifiable and meaningful specification.

These tests conclusively and scientifically demonstrate that the affected or blasted areas of concrete & asphalt return to equilibrium moisture content readings in approximately 20-25 minutes using the Stripe Hog, Stripe Removal System with the Smart Vac Vacuum. This means the affected areas were just as dry as or even dryer than they were before the removal process began in just 20 – 25 minutes time. These numbers may of course vary slightly as the outside weather conditions vary. These tests conclusively demonstrate that reapplication of new markings could be carried out in 20-30 minutes after a surface has been affected by the Stripe Hog, waterblasting removal system. The ability of the new markings to adhere to the blasted surface would be as great or greater so long as there is a 20 – 25 minute drying time realized.

This is only true for concrete & asphalt surfaces that are water blasted using the Stripe Hog with Smart Vac Vacuum recovery. This would not hold true for any other wetting process like rain or hosing down of the road surface. This is true because the Stripe Hog carries out a powerful vacuum extraction process removing a majority of the water and moisture immediately.

These tests were carried out and reported by:

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