STATE OF FLORIDA

COMPARISON OF THE SCOOPING VS. QUARTERING METHODS FOR OBTAINING ASPHALT MIXTURE SAMPLES

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ABSTRACT

The standard method of quartering plant produced asphalt mix to obtain samples for maximum specific gravity, gradation and asphalt binder content has been used by the Florida Department of Transportation (FDOT), contractors and independent testing laboratories for many years with great success. This report examines an alternative method for obtaining samples that is somewhat easier and less time consuming than the traditional quartering method. This method, hereafter referred to as the "scooping" method, involves some of the same procedures and techniques that are used with the quartering method. The principle difference is that samples are scooped from the pile of asphalt mix until the desired sample weight is obtained instead of quartering the pile down until the desired sample weight is obtained. Twelve different mixtures were sampled for this study and the following mixture properties were compared for the two different sampling methods: bulk density, maximum specific gravity, % air voids, asphalt binder content and gradation. Analysis of the data indicates that the two sampling methods provide statistically equivalent results for the aforementioned mixture properties. Included in this report is a new version of FM 1-T 168, "Sampling Bituminous Paving Mixtures", which encompasses this new method for sampling asphalt mixtures.

INTRODUCTION

With the implementation of Superpave, a need arose for a method to obtain representative asphalt mixture samples for bulk density (G_{mb}), maximum specific gravity (G_{mm}), and extraction/gradation in a systematic and timely manner. During the Marshall mix design era, G_{mb} samples were scooped directly from the bucket of asphalt mix that was shoveled from the truck. G_{mm} and extraction/gradation samples were subsequently quartered to the appropriate testing size. However, with the use of coarse graded Superpave mixtures and the added emphasis on the control of volumetric properties, there was a concern that scooping directly from the bucket may result in a non-representative sample. It was thought that if a bucket of mix was placed on paper and rolled in the typical quartering fashion and then samples were scooped from this pile in a systematic manner, that results could be obtained that matched those of the traditionally accepted quartering method. If the results did match, then the main benefit of scooping instead of quartering would be the time saved in obtaining the samples. This is a major concern for G_{mb} samples of coarse graded Superpave mixtures that can cool down quickly during the quartering process and would require extensive heating time to bring the samples back up to compaction temperature. This study was undertaken to provide a formal examination of the scooping and quartering sampling methods and determine if the two sampling methods provide statistically equivalent results.

EXPERIMENTAL PLAN

Twelve mixtures were examined consisting of coarse and fine graded Superpave mixtures and fine graded Marshall mixtures. Nine of the twelve mixtures were Superpave and seven of the twelve mixtures were coarse graded (gradation passing below the restricted zone). The variety of aggregate types included in this study consisted of limestone aggregates from Florida and Alabama and granite aggregates from Georgia and Nova Scotia. Nominal maximum aggregate sizes ranged from 19 mm to 9.5 mm. For each particular mix, two large silicone-lined boxes were filled by shoveling mix from the truck bed at the asphalt plant. One box was used for obtaining the scooped samples and the other box was used for the quartered samples. In some instances the boxes of mix were reduced to sample size directly at the asphalt plant but in a majority of the cases the mixtures were allowed to cool in the boxes and then brought back to the State Materials Office Bituminous Research Lab where they were reheated and reduced to the appropriate sample size using both methods.

For the nine Superpave mixtures, two samples were obtained for G_{mb}, two for G_{mm} and in most cases two for extraction/gradation for each sampling technique. For the first three mixes, only one extraction/gradation sample was obtained. For the three Marshall mixtures, two samples were obtained for G_{mm} and two for extraction/gradation. Samples were not obtained for G_{mb} because these samples were historically being obtained by scooping out of a bucket and this comparison was not of interest.

The G_{mb} samples were compacted to the N_{max} gyration level for the particular mix in accordance with AASHTO TP-4. The G_{mm} samples were tested according to FM 1-T 209, which includes a dry-back procedure. The extraction/gradation samples were tested using an ignition oven with automated printout of asphalt binder content. The gradation of the post-ignition sample was determined in accordance with FM 1-T 030.

DESCRIPTION OF SAMPLING PROCEDURES

Quartering Method

In this method, the bucket of asphalt mix that is shoveled from the truck bed is dumped onto a sheet of heavy paper and rolled back and forth to recombine the mix to obtain a more uniform and representative sample. A quartering device is inserted into the pile and opposite quarters are removed to reduce the size of the pile. This process continues until the combination of opposite quarters produces the desired sample size.

Scooping Method

As in the quartering method, the bucket of asphalt mix that is shoveled from the truck bed is dumped onto a sheet of heavy paper and rolled back and forth to recombine the mix to obtain a more uniform and representative sample. However, from this point on samples are scooped from the pile using a medium (3” wide X 5” long) to large (5” wide X 8” long) round scoop. After each sample is taken, the remaining pile of mix is recombined by rolling. The complete procedure is outlined in **Figure 1**. The revised Florida method for sampling bituminous paving mixtures (FM 1-T 168) is included as **Appendix A**.

DATA ANALYSIS

Theoretically, if the two sampling methods were identical then the average difference between values obtained for any asphalt property (ex., asphalt binder content) for a particular mix would be zero. A paired difference analysis was performed for each property measured. A paired difference analysis is a t-test performed on the differences between each sampling method. A 95% confidence interval was used, i.e. $\alpha = 0.05$, to calculate the two-sided t-critical value. The null hypothesis is that the average difference is zero. If t-calculated is less than t-critical, then the null hypothesis cannot be rejected.

The asphalt mixture properties analyzed were: G_{mb}, G_{mm}, % air voids, % asphalt binder, and the percent passing for the following sieve sizes (1/2", 3/8", No. 4, 8, 16, 30, 50, 100 and 200). The test data, differences, average difference, and t-test results for each of the asphalt mixture properties are shown in **Tables 1-13**. In the t-test summaries, the important values are the "t Stat" and the "t Critical two-tail" values. For simplicity, all of these "t" values have been summarized in **Table 14**.

Examination of the statistical results indicate that for all of the properties measured, except for % passing the No. 4 sieve, the null hypothesis cannot be rejected. This indicates that the two methods are statistically equivalent. The one exception is for the % passing the No. 4 sieve. The average difference was 1.3%. The t-calculated and t-critical values were nearly identical (2.224 vs. 2.228). Closer examination of the data reveals that for Superpave mix SP99-0290C the difference between the two sampling methods for the % passing the No. 4 sieve was 4.9 %. This is one of the three mixes in which only one gradation was performed per sampling method. If this one value is removed from the data analysis, then the t-calculated value is less than the t-critical value (1.860 vs. 2.262).

For all of the sieve sizes, the quartering method produced a slightly finer gradation than the scooping method. The amount finer was less than 0.5% for each sieve size except for the No. 8 sieve, which was 0.7% finer and the No. 4 sieve, which was 1.3 % finer. For the other asphalt mixture properties analyzed the average difference (scooping – quartering) was as follows: G_{mb}

(0.003), G_{mm} (-0.001), % air voids (-0.19) and % asphalt binder (-0.02). These values are nearly zero and indicate strong agreement between the two sampling methods. **Table 15** summarizes all of the individual differences for each mixture property and mix type tested as well as the average difference.

CONCLUSION

Based on the statistical analysis of the data, the two methods of sampling are equivalent with respect to G_{mb}, G_{mm}, asphalt binder content and gradation. Since the scooping method is easier and faster it is recommended that the revised Florida method for sampling (FM 1-T 168) be accepted and implemented statewide. Training venues for this new method exist through the Construction Training and Qualification Program (CTQP) and through Field Operations personnel at the State Materials Office.

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Table 1 - G_{mb} Data

Mix Design Info.	Gmb (Nmax) Scoop	Quarter	Scoop - Quarter
SP99-0230B, 12.5C	2.340	2.335	0.005
SP99-0290B, 12.5C	2.247	2.242	0.005
SP99-0290C, 12.5C	2.151	2.160	-0.009
SP99-0291A, 12.5C	2.250	2.245	0.005
SP99-0272A, 9.5C	2.308	2.310	-0.002
SP98-0204B, 12.5C	2.302	2.304	-0.002
SP98-0193B, 12.5C	2.347	2.337	0.010
SP00-0559A, 19.0F	2.410	2.402	0.008
SP00-0238B, 9.5F	2.355	2.349	0.006
		Avg. Diff.	0.003

t-Test: Paired Two Sample for Means

	Variable 1	*Variable 2*
Mean	2.30111111	2.29822222
Variance	0.00581261	0.00518444
Observations	9	9
Pearson Correlation	0.99834635	
Hypothesized Mean Difference	0	
df	8	
t Stat	1.44222051	
P(T<=t) one-tail	0.09361018	
t Critical one-tail	1.85954832	
P(T<=t) two-tail	0.18722035	
t Critical two-tail	2.30600563	

Table 2 - G_{mm} Data

Mix Design Info.	Gmm Scoop	Quarter	Scoop - Quarter
SP99-0230B, 12.5C	2.407	2.405	0.002
SP99-0290B, 12.5C	2.307	2.319	-0.012
SP99-0290C, 12.5C	2.320	2.321	-0.001
SP99-0291A, 12.5C	2.282	2.281	0.001
SP99-0272A, 9.5C	2.319	2.320	-0.001
SP98-0204B, 12.5C	2.331	2.334	-0.003
Atlantic Coast, S-II	2.433	2.441	-0.008
SP98-0193B, 12.5C	2.397	2.402	-0.005
SP00-0559A, 19.0F	2.467	2.464	0.003
SP00-0238B, 9.5F	2.406	2.404	0.002
QA00-9366A, ABC-3	2.471	2.466	0.005
QA94-6538B, S-III	2.358	2.355	0.003
		Avg. Diff.	-0.001

t-Test: Paired Two Sample for Means

	Variable 1	*Variable 2*
Mean	2.37483333	2.376
Variance	0.00410652	0.00391
Observations	12	12
Pearson Correlation	0.99712816	
Hypothesized Mean Difference	0	
df	11	
t Stat	-0.80151823	
P(T<=t) one-tail	0.21990138	
t Critical one-tail	1.79588369	
P(T<=t) two-tail	0.43980277	
t Critical two-tail	2.20098627	

Table 3 - % Air Voids Data

Mix Design Info.	% Air Voids Scoop	Quarter	Scoop - Quarter
SP99-0230B, 12.5C	2.78	2.91	-0.13
SP99-0290B, 12.5C	2.60	3.32	-0.72
SP99-0290C, 12.5C	7.28	6.94	0.35
SP99-0291A, 12.5C	1.40	1.58	-0.18
SP99-0272A, 9.5C	0.47	0.43	0.04
SP98-0204B, 12.5C	1.24	1.29	-0.04
SP98-0193B, 12.5C	2.09	2.71	-0.62
SP00-0559A, 19.0F	2.31	2.52	-0.21
SP00-0238B, 9.5F	2.12	2.29	-0.17
		Avg. Diff.	-0.19

t-Test: Paired Two Sample for Means

	Variable 1	*Variable 2*
Mean	2.47840816	2.66360746
Variance	3.77689767	3.37226111
Observations	9	9
Pearson Correlation	0.98696509	
Hypothesized Mean Difference	0	
df	8	
t Stat	-1.71871335	
P(T<=t) one-tail	0.06199365	
t Critical one-tail	1.85954832	
P(T<=t) two-tail	0.12398731	
t Critical two-tail	2.30600563	

Table 4 - % Asphalt Binder Content Data

Mix Design Info.	% AC (ignition) Scoop	Quarter	Scoop - Quarter
SP99-0230B, 12.5C	5.21	5.32	-0.11
SP99-0290B, 12.5C	6.97	6.91	0.06
SP99-0290C, 12.5C	6.87	7.09	-0.22
SP99-0291A, 12.5C	7.04	7.04	0.00
SP99-0272A, 9.5C	8.36	8.40	-0.04
SP98-0204B, 12.5C	6.96	7.14	-0.18
Atlantic Coast, S-II	5.72	5.57	0.15
SP98-0193B, 12.5C	7.15	6.91	0.24
SP00-0559A, 19.0F	6.24	6.20	0.04
SP00-0238B, 9.5F	7.34	7.22	0.12
QA00-9366A, ABC-3	5.53	5.81	-0.28
QA94-6538B, S-III	7.83	7.90	-0.07
		Avg. Diff.	-0.02

t-Test: Paired Two Sample for Means

	Variable 1	*Variable 2*
Mean	6.76833333	6.7925
Variance	0.8758697	0.84278409
Observations	12	12
Pearson Correlation	0.9858749	
Hypothesized Mean Difference	0	
df	11	
t Stat	-0.53385925	
P(T<=t) one-tail	0.3020298	
t Critical one-tail	1.79588369	
P(T<=t) two-tail	0.60405959	
t Critical two-tail	2.20098627	

Table 5 - % Passing 1/2" Sieve Data

Mix Design Info.	% Passing 1/2" Sieve Scoop	Quarter	Scoop - Quarter
SP99-0230B, 12.5C	95.6	97.2	-1.6
SP99-0290C, 12.5C	99.3	99.6	-0.3
SP99-0291A, 12.5C	100.0	100.0	0.0
SP99-0272A, 9.5C	100.0	99.9	0.1
SP98-0204B, 12.5C	95.2	95.5	-0.3
Atlantic Coast, S-II	89.3	87.5	1.8
SP98-0193B, 12.5C	97.6	97.8	-0.2
SP00-0559A, 19.0F	91.8	91.3	0.5
SP00-0238B, 9.5F	99.6	99.6	0.0
QA00-9366A, ABC-3	94.3	96.5	-2.2
QA94-6538B, S-III	99.6	99.7	-0.1
		Avg. Diff.	-0.2

t-Test: Paired Two Sample for Means

	Variable 1	*Variable 2*
Mean	96.5727273	96.7818182
Variance	13.3981818	16.3616364
Observations	11	11
Pearson Correlation	0.96903298	
Hypothesized Mean Difference	0	
df	10	
t Stat	-0.67200921	
P(T<=t) one-tail	0.25840116	
t Critical one-tail	1.81246151	
P(T<=t) two-tail	0.51680231	
t Critical two-tail	2.22813924	

Table 6 - % Passing 3/8" Sieve Data

Mix Design Info.	% Passing 3/8" Sieve Scoop	Quarter	Scoop - Quarter
SP99-0230B, 12.5C	89.5	90.2	-0.7
SP99-0290C, 12.5C	95.4	97.9	-2.5
SP99-0291A, 12.5C	91.9	92.3	-0.4
SP99-0272A, 9.5C	98.4	98.0	0.4
SP98-0204B, 12.5C	88.1	88.7	-0.6
Atlantic Coast, S-II	82.4	79.0	3.4
SP98-0193B, 12.5C	91.4	92.7	-1.3
SP00-0559A, 19.0F	86.4	86.0	0.4
SP00-0238B, 9.5F	99.4	99.3	0.1
QA00-9366A, ABC-3	83.2	86.3	-3.1
QA94-6538B, S-III	96.9	97.0	-0.1
		Avg. Diff.	-0.4

t-Test: Paired Two Sample for Means

	Variable 1	*Variable 2*
Mean	91.1818182	91.5818182
Variance	34.6716364	39.9376364
Observations	11	11
Pearson Correlation	0.96393694	
Hypothesized Mean Difference	0	
df	10	
t Stat	-0.78309669	
P(T<=t) one-tail	0.22585872	
t Critical one-tail	1.81246151	
P(T<=t) two-tail	0.45171745	
t Critical two-tail	2.22813924	

Table 7 - % Passing No. 4 Sieve Data

Mix Design Info.	% Passing No. 4 Sieve		
	Scoop	Quarter	Scoop - Quarter
SP99-0230B, 12.5C	57.4	60.4	-3.0
SP99-0290C, 12.5C	60.1	65.0	-4.9
SP99-0291A, 12.5C	57.0	57.1	-0.1
SP99-0272A, 9.5C	71.3	72.4	-1.1
SP98-0204B, 12.5C	55.7	57.4	-1.7
Atlantic Coast, S-II	63.1	60.5	2.6
SP98-0193B, 12.5C	60.2	60.3	-0.1
SP00-0559A, 19.0F	68.7	70.2	-1.5
SP00-0238B, 9.5F	79.7	80.5	-0.8
QA00-9366A, ABC-3	55.6	58.1	-2.5
QA94-6538B, S-III	73.3	74.2	-0.9
		Avg. Diff.	-1.3

t-Test: Paired Two Sample for Means

	Variable 1	*Variable 2*
Mean	63.8272727	65.1
Variance	67.0501818	63.786
Observations	11	11
Pearson Correlation	0.97277079	
Hypothesized Mean Difference	0	
df	10	
t Stat	-2.22407218	
P(T<=t) one-tail	0.02517294	
t Critical one-tail	1.81246151	
P(T<=t) two-tail	0.05034588	
t Critical two-tail	2.22813924	

Table 8 - % Passing No. 8 Sieve Data

Mix Design Info.	% Passing No. 8 Sieve		
	Scoop	Quarter	Scoop - Quarter
SP99-0230B, 12.5C	35.5	36.5	-1.0
SP99-0290C, 12.5C	29.0	30.0	-1.0
SP99-0291A, 12.5C	27.0	26.7	0.3
SP99-0272A, 9.5C	41.0	42.8	-1.8
SP98-0204B, 12.5C	30.3	32.3	-2.0
Atlantic Coast, S-II	48.5	46.1	2.4
SP98-0193B, 12.5C	31.8	31.8	0.0
SP00-0559A, 19.0F	51.8	53.8	-2.0
SP00-0238B, 9.5F	56.1	56.6	-0.5
QA00-9366A, ABC-3	45.2	47.0	-1.8
QA94-6538B, S-III	55.4	55.9	-0.5
		Avg. Diff.	-0.7

t-Test: Paired Two Sample for Means

	Variable 1	*Variable 2*
Mean	41.0545455	41.7727273
Variance	119.524727	119.396182
Observations	11	11
Pearson Correlation	0.99281937	
Hypothesized Mean Difference	0	
df	10	
t Stat	-1.81852019	
P(T<=t) one-tail	0.04950795	
t Critical one-tail	1.81246151	
P(T<=t) two-tail	0.09901589	
t Critical two-tail	2.22813924	

Table 9 - % Passing No. 16 Sieve Data

Mix Design Info.	% Passing No. 16 Sieve		
	Scoop	Quarter	Scoop - Quarter
SP99-0230B, 12.5C	25.0	25.5	-0.5
SP99-0290C, 12.5C	22.4	22.6	-0.2
SP99-0291A, 12.5C	20.7	20.5	0.2
SP99-0272A, 9.5C	24.7	24.7	0.0
SP98-0204B, 12.5C	16.6	16.9	-0.3
Atlantic Coast, S-II	39.5	37.8	1.7
SP98-0193B, 12.5C	19.9	19.9	0.0
SP00-0559A, 19.0F	38.1	39.9	-1.8
SP00-0238B, 9.5F	43.9	44.4	-0.5
QA00-9366A, ABC-3	41.0	42.4	-1.4
QA94-6538B, S-III	45.8	46.1	-0.3
		Avg. Diff.	-0.3

t-Test: Paired Two Sample for Means

	Variable 1	*Variable 2*
Mean	30.6909091	30.9727273
Variance	119.336909	123.574182
Observations	11	11
Pearson Correlation	0.99686802	
Hypothesized Mean Difference	0	
df	10	
t Stat	-1.04655698	
P(T<=t) one-tail	0.15997048	
t Critical one-tail	1.81246151	
P(T<=t) two-tail	0.31994096	
t Critical two-tail	2.22813924	

Table 10 - % Passing No. 30 Sieve Data

Mix Design Info.	% Passing No. 30 Sieve		
	Scoop	Quarter	Scoop - Quarter
SP99-0230B, 12.5C	19.4	19.7	-0.3
SP99-0290C, 12.5C	18.6	18.8	-0.2
SP99-0291A, 12.5C	16.9	16.8	0.1
SP99-0272A, 9.5C	15.2	15.0	0.2
SP98-0204B, 12.5C	10.3	10.3	0.0
Atlantic Coast, S-II	34.3	32.9	1.4
SP98-0193B, 12.5C	14.7	14.6	0.1
SP00-0559A, 19.0F	28.6	30.1	-1.5
SP00-0238B, 9.5F	34.7	35.3	-0.6
QA00-9366A, ABC-3	37.5	38.8	-1.3
QA94-6538B, S-III	38.9	38.9	0.0
		Avg. Diff.	-0.2

t-Test: Paired Two Sample for Means

	Variable 1	*Variable 2*
Mean	24.4636364	24.6545455
Variance	109.598545	113.486727
Observations	11	11
Pearson Correlation	0.99743995	
Hypothesized Mean Difference	0	
df	10	
t Stat	-0.81410027	
P(T<=t) one-tail	0.21727249	
t Critical one-tail	1.81246151	
P(T<=t) two-tail	0.43454499	
t Critical two-tail	2.22813924	

Table 11 - % Passing No. 50 Sieve Data

Mix Design Info.	% Passing No. 50 Sieve		
	Scoop	Quarter	Scoop - Quarter
SP99-0230B, 12.5C	14.2	14.4	-0.2
SP99-0290C, 12.5C	14.9	15.0	-0.1
SP99-0291A, 12.5C	12.8	12.8	0.0
SP99-0272A, 9.5C	10.1	10.0	0.1
SP98-0204B, 12.5C	7.3	7.2	0.1
Atlantic Coast, S-II	29.7	28.5	1.2
SP98-0193B, 12.5C	10.7	10.6	0.1
SP00-0559A, 19.0F	20.5	21.5	-1.0
SP00-0238B, 9.5F	24.8	25.7	-0.9
QA00-9366A, ABC-3	29.1	30.1	-1.0
QA94-6538B, S-III	30.6	30.5	0.1
		Avg. Diff.	-0.1

t-Test: Paired Two Sample for Means

	Variable 1	*Variable 2*
Mean	18.6090909	18.7545455
Variance	74.8549091	76.2587273
Observations	11	11
Pearson Correlation	0.99732503	
Hypothesized Mean Difference	0	
df	10	
t Stat	-0.75274325	
P(T<=t) one-tail	0.23447686	
t Critical one-tail	1.81246151	
P(T<=t) two-tail	0.46895372	
t Critical two-tail	2.22813924	

Table 12 - % Passing No. 100 Sieve Data

Mix Design Info.	% Passing No. 100 Sieve		
	Scoop	Quarter	Scoop - Quarter
SP99-0230B, 12.5C	8.9	9.0	-0.1
SP99-0290C, 12.5C	9.9	10.0	-0.1
SP99-0291A, 12.5C	7.9	7.9	0.0
SP99-0272A, 9.5C	7.4	7.2	0.2
SP98-0204B, 12.5C	5.9	5.6	0.3
Atlantic Coast, S-II	13.7	13.1	0.6
SP98-0193B, 12.5C	7.4	7.4	0.0
SP00-0559A, 19.0F	11.8	12.1	-0.3
SP00-0238B, 9.5F	12.9	14.0	-1.1
QA00-9366A, ABC-3	12.5	13.0	-0.5
QA94-6538B, S-III	16.1	15.7	0.4
		Avg. Diff.	-0.05

t-Test: Paired Two Sample for Means

	Variable 1	*Variable 2*
Mean	10.4	10.4545455
Variance	10.3	10.8607273
Observations	11	11
Pearson Correlation	0.99001117	
Hypothesized Mean Difference	0	
df	10	
t Stat	-0.38681512	
P(T<=t) one-tail	0.35349846	
t Critical one-tail	1.81246151	
P(T<=t) two-tail	0.70699691	
t Critical two-tail	2.22813924	

Table 13 - % Passing No. 200 Sieve Data

Mix Design Info.	% Passing No. 200 Sieve Scoop	Quarter	Scoop - Quarter
SP99-0230B, 12.5C	6.1	6.2	-0.1
SP99-0290C, 12.5C	6.4	6.4	0.0
SP99-0291A, 12.5C	4.5	4.6	-0.1
SP99-0272A, 9.5C	6.0	5.7	0.3
SP98-0204B, 12.5C	5.0	4.8	0.2
Atlantic Coast, S-II	4.8	4.5	0.3
SP98-0193B, 12.5C	4.8	4.9	-0.1
SP00-0559A, 19.0F	6.5	6.4	0.1
SP00-0238B, 9.5F	6.2	7.2	-1.0
QA00-9366A, ABC-3	5.9	6.3	-0.4
QA94-6538B, S-III	7.8	7.4	0.4
		Avg. Diff.	-0.04

t-Test: Paired Two Sample for Means

	Variable 1	*Variable 2*
Mean	5.81818182	5.85454545
Variance	0.94763636	1.05672727
Observations	11	11
Pearson Correlation	0.92326617	
Hypothesized Mean Difference	0	
df	10	
t Stat	-0.30481997	
P(T<=t) one-tail	0.38337641	
t Critical one-tail	1.81246151	
P(T<=t) two-tail	0.76675282	
t Critical two-tail	2.22813924	

Table 14 – Summary of Paired Difference Analysis

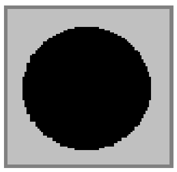
Asphalt Mixture Property	Abs. value t-calculated	t-critical	t-calc. < t-crit. ?
Gmb (Nmax)	1.442	2.306	YES
Gmm	0.802	2.201	YES
% Air Voids	1.719	2.306	YES
% AC (ignition)	0.534	2.201	YES
Sieve Size			
1/2"	0.672	2.228	YES
3/8"	0.783	2.228	YES
No. 4	2.224	2.228	Equal
No. 8	1.819	2.228	YES
No. 16	1.047	2.228	YES
No. 30	0.814	2.228	YES
No. 50	0.753	2.228	YES
No. 100	0.387	2.228	YES
No. 200	0.305	2.228	YES

Table 15 – Summary of Differences for Each Asphalt Mixture Property

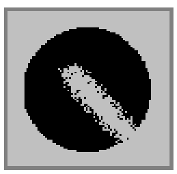
	Difference (Scoop - Quarter)												
Property	SP99-0230B 12.5 C	SP99-0290B 12.5 C	SP99-0290C 12.5 C	SP99-0291A 12.5 C	SP99-0272A 9.5 C	SP98-0204B 12.5 C	Atlantic Coast S-II	SP98-0193B 12.5 C	SP00-0559A 19.0 F	SP99-0238B 9.5 F	QA00-9366A ABC-3	QA94-6538B S-III	Average Difference
Gmb (Nmax)	0.005	0.005	-0.009	0.005	-0.002	-0.002		0.010	0.008	0.006			0.003
Gmm	0.002	-0.012	-0.001	0.001	-0.001	-0.003	-0.008	-0.005	0.003	0.002	0.005	0.003	-0.001
% Air Voids	-0.13	-0.72	0.35	-0.18	0.04	-0.04		-0.62	-0.21	-0.17			-0.19
% AC (ignition)	-0.11	0.06	-0.22	0.00	-0.04	-0.18	0.15	0.24	0.04	0.12	-0.28	-0.07	-0.02
Sieve Size													
3/4"	0.0	unknown	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0
1/2"	-1.6	unknown	-0.3	0.0	0.1	-0.3	1.8	-0.2	0.5	0.0	-2.2	-0.1	-0.2
3/8"	-0.7	unknown	-2.5	-0.4	0.4	-0.6	3.4	-1.3	0.4	0.1	-3.1	-0.1	-0.4
No. 4	-3.0	unknown	-4.9	-0.1	-1.1	-1.7	2.6	-0.1	-1.5	-0.8	-2.5	-0.9	-1.3
No. 8	-1.0	unknown	-1.0	0.3	-1.8	-2.0	2.4	0.0	-2.0	-0.5	-1.8	-0.5	-0.7
No. 16	-0.5	unknown	-0.2	0.2	0.0	-0.3	1.7	0.0	-1.8	-0.5	-1.4	-0.3	-0.3
No. 30	-0.3	unknown	-0.2	0.1	0.2	0.0	1.4	0.1	-1.5	-0.6	-1.3	0.0	-0.2
No. 50	-0.2	unknown	-0.1	0.0	0.1	0.1	1.2	0.1	-1.0	-0.9	-1.0	0.1	-0.1
No. 100	-0.1	unknown	-0.1	0.0	0.2	0.3	0.6	0.0	-0.3	-1.1	-0.5	0.4	-0.1
No. 200	-0.1	unknown	0.0	-0.1	0.3	0.2	0.3	-0.1	0.1	-1.0	-0.4	0.4	-0.04

Figure 1 – Scooping Procedure

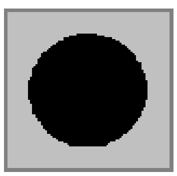
Obtain approximately equal portions from 3 well seperated locations in the truck



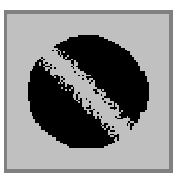
Place sample on paper and recombine by rolling to minimize segregation



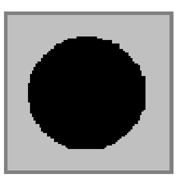
SGC specimen # 1
Using a round scoop "QUICKLY" scoop mass required for SGC specimen. Scoop straight through the center keeping the scoop on the paper.



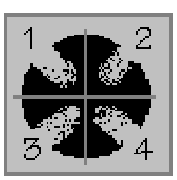
Quickly recombine mix by rolling.



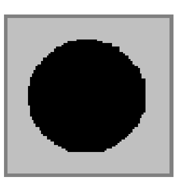
SGC specimen # 2
Quickly scoop mass required for SGC specimen. Scoop straight through the center keeping the scoop on the paper.



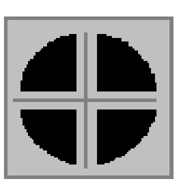
Recombine mix by rolling.



Scoop mass reqired for Ext/Grd from two opposite quarters (1 & 4); for Gmm one specimen from one quarter (2) and one from the opposite quarter (3).



Recombine mix by rolling.



Fill boxes as needed from remaining mix.

APPENDIX

Florida Method
for

SAMPLING BITUMINOUS PAVING MIXTURES

Designation: FM 1-T 168

1. SCOPE

1.1 This method covers the procedure for sampling mixtures of bituminous hot mix asphalt at the asphalt plant and roadway.

2. SIZE OF SAMPLE

2.1 The size of the composite sample shall be of sufficient size to provide the correct number of samples for the testing required.

3. SAMPLING AT PLANT

3.1 Obtain approximately equal portions from at least three well-separated locations in the truck immediately after the truck completes loading and moves to an accessible position. Samples shall be taken from a depth of approximately 12 in. (300 mm) below the surface. Take care to avoid contamination and segregation.

3.2 Reduce to the required amount for testing using one of the following methods.

3.2.1 SUPERPAVE MIXES

3.2.1.1 Place sample on paper and recombine to reduce segregation.

3.2.1.2 Using a medium (3” wide X 5” long) or large (5” wide X 8” long) round scoop and beginning at the edge of the pile with the scoop on the paper, scoop the correct mass needed for the first Superpave Gyratory Compactor (SGC) specimen. Scoop straight through the center of the pile until the desired amount of mix is obtained.

3.2.1.3 Recombine the remainder of the mix and repeat the above procedure to obtain the number of SGC specimens needed.

3.2.1.4 Recombine the remainder of the mix and insert the quartering device into the mix. With the scoop on the paper, scoop the correct mass needed for the extraction / gradation from opposite quarters. Scoop straight towards the center of the pile and obtain approximately equal amounts from both quarters.

3.2.1.5 With the scoop on the paper, scoop the correct mass needed for the maximum specific gravity test from the remaining two quarters. Scoop straight towards center of the pile and approximately equal amounts from both quarters.

3.2.1.6 Recombine the remainder of the mix and insert the quartering device. Fill the required number of boxes by continuing the quartering process.

3.2.2 MARSHALL MIXES

3.2.2.1 Using a medium or larger round scoop, obtain the appropriate amount of material necessary for the compaction of Marshall specimens by scooping the mix directly from the sample.

3.2.2.2 Place the remainder of the mix on the paper to be reduced to testing size and boxed as needed.

3.2.2.3 Recombine the mix and insert the quartering device into the mix. With the scoop on the paper scoop the correct mass needed for the extraction / gradation from opposite quarters. Scoop straight towards the center of the pile and obtain approximately equal amounts from both quarters.

3.2.2.4 With the scoop on the paper, scoop the correct mass needed for the maximum specific gravity test from the two remaining quarters. Scoop straight towards the center of the pile and obtain approximately equal amounts from both quarters.

3.2.2.5 Recombine the remainder of the mix and insert the quartering device. Fill the required number of boxes by continuing the quartering process.

3.2.3 OPEN GRADED MIXES (Refer to **Figure 1**)

3.2.3.1 Because of the difficulty in determining an accurate asphalt content in open graded mix (FC-2, FC-5), the following method should be used in obtaining a sample.

3.2.3.2 Obtain the composite sample as described in 2.1 and 3. 1.

3.2.3.3 Place the composite sample on the paper for quartering. With the use of a quartering device, divide the sample in four approximately equal size portions.

3.2.3.4 Obtain a single sample for testing (asphalt content and gradation), by scooping a sample of the appropriate size directly into the scale pan. Approximately one half of the scoop sample should be taken from each of No. 1 and No. 4 portions of the quartered pile.

3.2.3.5 Obtain two additional samples from the No. 1 and No. 4 portions in two non-absorptive boxes or metal cans as described in 3.2.3.4 above for referee testing of Asphalt Content by the Central and District Laboratories. Discard remainder of portions No. 1 and No. 4.

3.2.3.6 Combine portions No. 2 and No. 3 by rolling on the quartering paper to form a uniform pile and insert the quartering device into the mix.

3.2.3.7 Remove opposite quarters, portions No. 5 and No. 8, and box together for referee testing of gradation by the Central Laboratory.

3.2.3.8 Combine remaining two quarters, portions No. 6 and No. 7, and box for referee testing of gradation by the District Laboratory.

4. SAMPLING PLANT-MIXED BITUMINOUS MIXTURES FROM ROADWAY

The following describes the procedure for sampling the bituminous paving mixture from the roadway. The size of sample depends upon the purpose for which the sample is being obtained and test(s) required.

4.1 HOT NON-COMPACTED MIX

Using a square-tipped shovel remove uncompacted mix from the roadway in the quantity needed. The full depth of the uncompacted mat should be sampled. Mix should be sampled from the left, center and right portions of the mat. Small pieces of sheet metal may need to be placed on the underlying layer in the sampling locations prior to paving the mat to prevent pickup of the underlying material. Place the sampled mix in a suitable container for transport to the testing lab. The container of mix should be thoroughly combined by rolling on paper before obtaining individual test samples.

4.2 FINISHED PAVEMENT

4.2.1 APPARATUS

4.2.1.1 Diamond bit core drill, concrete saw or other suitable device.

4.2.2 PROCEDURE

4.2.2.1 Allow the pavement to cool sufficiently to permit coring or sawing without damage to the specimen.

4.1.2.2 Obtain the sample from the pavement by cutting with a diamond bit core drill or by a concrete saw.

4.1.2.3 If a density determination is to be made the sample shall be transported in a appropriate manner to prevent damage.

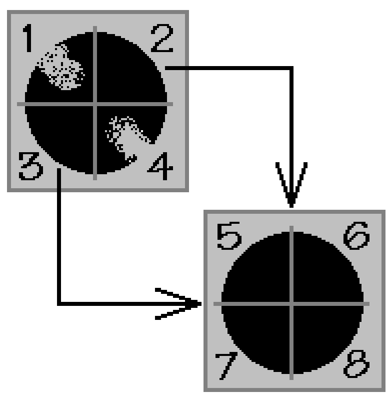


Figure 1 - Sampling Open graded Friction Course Mixes at Asphalt Plant