Asphalt Content by Ignition: Round-Robin Experiment

By

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15. Abstract

A round-robin experiment involving 10 laboratories, 5 mixtures, and 3 replicates for each mix was conducted to obtain data to serve as the basis for determining precision of the ignition method for measurement of asphalt content and gradation. Asphalt contents were also determined using reflux and centrifuge extractions as well as nuclear asphalt gage measurements. An ignition test procedure was developed for use with ovens not having an internal balance, which requires measurements of all weights at specific temperatures and a determination of appropriate burn times for specific materials. Test results indicated the precision is equal to that reported for reflux extractions and nuclear asphalt gages. Aggregate gradations were not changed by the ignition test based on a comparison of before and after gradation data. It is recommended that the ignition method be implemented for determination of asphalt cement content of bituminous mixtures.

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SI* (MODERN METRIC) CONVERSION FACTORS

Symbol	When You Know	Multiple By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yards	0.836	square meters	m^2
ac	acres	0.405	hectares	km^2
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	ml
gal	gallons	3.785	liters	l
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
NOTE: Volumes greater than 1000 L shall be shown in m^3.				
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
		TEMPERATURE (exact)		
ºF	Fahrenheit temperature	5(F-32)1/9 or (F-32)/1.8	Celsius temperature	ºC
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
		FORCES and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
psi	poundforce per square inch	6.89	kilopascals	kPa

*SI is the symbol for the International System of Units. Appropriate rounding should be made†to comply with Section 4 of ASTM E380.

SI (MODERN METRIC) CONVERSION FACTORS (continued)

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiple By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
km^2	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
ml	milliliters	0.034	fluid ounces	fl oz
l	liters	0.264	gallons	gal
m^3	cubic meters	35.71	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg	megagrams	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact)		
ºC	Celsius temperature	1.8C+32	Fahrenheit temperature	ºF
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
		FORCES and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	psi

(Revised August 1992)

Introduction

Hot mixed asphalt (HMA) pavement construction requires monitoring material quality throughout production and construction operations. Quality control testing is used to monitor material production and construction processes; quality assurance testing is the basis for acceptance of construction materials and contractor payment. Presently on New Mexico State Highway and Transportation Department (NMSHTD) projects, tank strap measurements are routinely used for asphalt quantity measurements and estimates of average asphalt content of mixtures. Present criteria require mixes to be at the design asphalt content ± 0.3 percent. When there is an indication of unacceptable variation in asphalt content based on tank strap measurements, a chemical extraction is used to resolve whether the mix is within specification requirements for purposes of acceptance.

The asphalt cement content of mixes is an important physical characteristic and influences the performance life of asphalt concrete pavements. Too much asphalt cement results in mixture stability problems, while too little asphalt cement results in a mixture that is not durable (Asphalt Institute Handbook, 1989; Roberts et. al., 1996).

In 1995 the Materials Research Center (MRC), ATR Institute, University of New Mexico completed a technology search to identify an alternative method of measuring the asphalt cement content of HMA mixes, because the tank strap method is not considered sufficiently precise. Furthermore, there is a moratorium (effective 1996) on the manufacture of chlorinated solvents used in chemical extraction testing methods. These solvents are essential to the current asphalt extraction methods used to determine asphalt content of mixes, thus a new method is needed. The MRC made the following recommendations:

> It is recommended that the ignition method and automatic recordation should be further evaluated under conditions and with materials routinely used in New Mexico. Carefully conducted experimental evaluations should be completed with direct comparisons to existing methods (chemical extractions and nuclear asphalt gages). At present there is no standard for the ignition test method although a proposed AASHTO Standard is in preparation by the National Center for Asphalt Technology (NCAT) (McKeen, 1995, pg. 24).

NMSHTD has begun to acquire equipment for performing asphalt determinations based on the ignition method. A contract was initiated by the NMSHTD to conduct a round-robin experiment designed to evaluate the performance of ignition ovens in New Mexico on mixtures

prepared using local New Mexico aggregates and binders. Testing included reflux and centrifuge chemical extractions and nuclear asphalt gages for comparison to the ignition furnace results. Aggregate gradations were also determined for the ignition furnace and extraction samples. A total of five mixes were evaluated by testing three replications of each mix in each of 10 ignition ovens operated by the laboratories participating in the experiment. A test procedure was developed based on the existing American Association of State Highway and Transportation Officials (AASHTO) draft (August 1996) and NMSHTD experience to date.

The objective of the round-robin experiment was to measure the precision of the ignition furnaces in New Mexico when used to test typical New Mexico materials. Standard procedures were used for data analysis as described in ASTM C 802, "Standard Practice for Conducting an Interlaboratory Test Program to Determine the Precision of Test Methods for Construction Materials." This report presents the results of the round-robin experiment to determine the ignition oven test precision using New Mexico materials, laboratory facilities, and the test method described below.

Objective

The objective was to conduct a round-robin interlaboratory testing program using the ignition method to measure asphalt binder content in hot-mix asphalt mixtures representative of New Mexico materials. In Section 401 of the "NMSHTD Standards for Road and Bridge Construction," hot-mix asphalt is specified as plant mixed bituminous pavement (PMBP). The AASHTO draft procedure for the ignition method (August 1996) was used as the basis for the test procedure employed. Modifications to the test procedure were developed and are discussed below. The objective was accomplished by completing the following tasks:

(1) Obtain test results from a minimum of 10 different ignition ovens on samples of 5 different PMBP mixes.

(2) Evaluate test results using the statistical analysis procedures in ASTM C 802 and compute the results.

(3) Based on these results, provide a recommended implementation plan and test procedure using ignition ovens in testing PMBP materials for asphalt content.

Experiment Design

A minimum of 10 laboratories are recommended for round-robin experiments to determine estimates of the precision of test methods (ASTM C802). Eleven different laboratory facilities

initially participated in the experiment, involving 12 ignition ovens. In the end, results from 10 laboratories were available for use in the analysis of results. Two of the laboratories initially participating in the experiment were unable to complete the testing required. The final test matrix for the experiment was 10 labs: 5 mixes: 3 repetitions for each mix. Each test facility is identified in Table 1.

Test Procedure

Using the AASHTO draft procedure, Method B (August 1996), as a guide in combination with NMSHTD experience, a test procedure for this experiment was developed. Method B was used as a basis because most of the ovens in use in New Mexico do not have internal balances. One laboratory in this experiment used a Troxler ignition oven, which has an internal balance and therefore does not readily adapt to the Method B procedure. A reporting form developed and used in the laboratory is shown in Appendix I. The essential characteristics of the test procedure are summarized in Table 2. Initial and final weights were all measured at 149 ºC (300 ºF) to eliminate test variability due to moisture in the sample and the effects of heating the apparatus. In this procedure the sample is initially burned at 538 ºC (1000 ºF) for 45 minutes. This is followed by cooling to the weighing temperature followed by a second burn at 538 ºC (1000 ºF) for 15 minutes.

Table 1. Laboratories in Round-Robin Experiment.

Lab	Mfg./Model No.	Location	Affiliation
1	Gilson/HM 278	Deming	NMSHTD, District 1
2	Gilson/HM 278	Roswell	NMSHTD, District 2
3	Gilson/HM 278	Albuquerque	NMSHTD, District 3
4	Gilson/HM 278	Las Vegas	NMSHTD, District 4
5	Gilson/HM 278	Santa Fe	NMSHTD, District 5
6	Gilson/HM 278	Milan	NMSHTD, District 6
7	Gilson/HM 278	Santa Fe	NMSHTD, Lab Bureau
8	Gilson/HM 278	Albuquerque	Bern. County PWD
9	Gilson/HM 278	Albuquerque	Assoc. Contractors NM
10	Troxler/4155	Albuquerque	Western Mobile
---	Reflux Extraction	Albuquerque	Matls. Res. Center
---	Nuclear, Troxler 4122	Albuquerque	Matls. Res. Center
---	Centrifuge Extraction	Albuquerque	NMSHTD, Hilltop Lab

Table 2. Summary of Test Procedure.

Item	Description	Comments
Sample	2000 g. (min.)	Nominal sample size
Initial & Tare Weights	149 ºC (300 ºF)	All weighings
1st burn	538 ºC (1000 ºF)/45 min.	Weight after burn
2nd burn	538 ºC (1000 ºF)/15 min.	Δ mass ≤ 0.02 percent?
Add'l burns	538 ºC (1000 ºF)/15 min.	Δ mass ≤ 0.02 percent?
Final Weight	149 ºC (300 ºF)	

The weight after the second burn is taken and compared to the first. If the difference in weight exceeds 0.02 percent, a third burn is required. This process is continued until the weight change is less than the 0.02 percent criteria.

This method is not intended to be suitable for routine use. However, it is an appropriate method for use during this round-robin experiment to determine the variability of materials as indicated by (1) the time required to achieve a fully burned sample and (2) no further weight loss upon exposure to the ignition temperature. It is also anticipated that this approach would be used when first testing new materials to determine a burn time required. After an appropriate burn time is determined by testing, multiple burns will not be needed. Ignition ovens with internal balances perform exactly the same kind of test, but it is done automatically, and the operator may not control the test parameters such as maximum temperature or test duration.

Once the weights before and after ignition are available the asphalt content is computed as a percent of initial weight as follows:

$$AC = \frac{W_i - W_f}{W_i}$$

where,

AC is asphalt content, usually reported as a percent of the initial weight

W_i = initial weight of sample, g

W_f = final weight of sample, g

In this experiment the aggregate remaining after ignition was tested to determine gradation. Samples were inspected to assess whether there were indications of particle breakdown based on visual inspection.

More test samples were made than were needed for the experiment in order provide replacement samples should irregularities or lost/damaged samples occur. Several laboratories deviated from the test procedure specified in the first set of tests. These tests were all rerun using the replacement samples available and did not impact the overall integrity of the testing program.

Test Samples

PMBP mixes tested are described in Table 3.

Material 1 was a NMSHTD B mix grading made with a sand and gravel aggregate from the Santa Ana Pit, north of Albuquerque. Table 4 shows NMSHTD Standard gradation limits. The binder was Diamond Shamrock 60/70 obtained from the Midland, Texas refinery. This mixture was a production mix prepared in the batch plant at the Western Mobile facility in Albuquerque. All materials used in the experiment were sampled from a single truckload; individual samples were prepared and distributed by the MRC laboratory in Albuquerque.

Material 2 was a NMSHTD B mix grading made with a caliche aggregate from the Armstrong Pit near Hobbs. The binder was a PAC 40 made using Navajo asphalt obtained from the Koch Materials Company facility in Artesia, New Mexico. The mixes were batched in small samples in the MRC Laboratory in Albuquerque before being distributed to the participating laboratories.

Material 3 was a NMSHTD B grading, using aggregate from the Santa Ana Pit (same as Material 1). Binder was AC 10 supplied by the Chevron facility in Albuquerque. This material was mixed in the MRC Laboratory facility in small batches that were distributed to the participating laboratories.

Material 4 was a NMSHTD A grading, using aggregate from the Santa Ana Pit (same as Materials 1 and 2 except for the gradation). The binder was Shamrock 60/70 from the Midland, Texas refinery. This material was mixed in the Western Mobile batch plant located at the Santa Pit

near Bernalillo and sampled from a single truckload. The sample was then divided into small samples at the MRC Laboratory and distributed to the participating laboratories.

Material 5 was made with a basalt aggregate meeting the 19-mm Superpave SIII gradation requirements. The binder was supplied by Chevron from Albuquerque, meeting the Superpave PG 58-28 requirements. The material was sampled in the field on Project No. IM-025-6(65)442 at Milepost 446 of I-25 in the windrow during paving of the southbound truck lane. Corn Construction, Inc., produced the mix in a Cedar Rapids parallel flow drum mix plant near the sampling site. The sample was then returned to the MRC Laboratory and divided into individual samples for distribution to the participating laboratories.

Table 3. Mixes Prepared for the Round-Robin Experiment.

Item	Material 1	Material 2	Material 3	Material 4	Material 5
Pit	Santa Ana	Armstrong	Santa Ana	Santa Ana	Mossiman
Rock Type	S&G	Caliche	S&G	S&G	Basalt
Grading	B	B	B	A	SIII
Binder Grade	60/70	PAC 40	AC 10	60/70	PG 58-28
Binder Source	DS	Navajo	Chevron	DS	Chevron
Design AC (%)	4.2	5.5	4.7	4.0	4.2
Lime (%)	1.5	none	none	1.5	1.5
Mix Producer	WM	MRC	MRC	WM	Corn

Table 4. Standard New Mexico Aggregate Gradations. *

Sieve Designation		Percent Passing				
		(PMBP)†				(OGFC)†
(mm)	(in)	A	B	C	D	
37.5	1.5	—	—	—	100	—
25.0	1.0	100	—	—	86-98	—
19.0	3/4	80-98	100	—	70-90	—
12.5	1/2	65-85	80-98	100	60-80	100
9.5	3/8	55-75	70-90	70-98	50-70	90-100
4.75	No. 4	40-55	50-65	45-70	34-54	25-55
2.00	No. 10	30-40	32-45	30-50	22-42	0-12
0.425	No. 40	10-20	10-22	15-25	8-22	0-8
0.075	No. 200	3-7	3-8	4-8	3-7	0-4

*NMSHTD 1994.

†PMBP is plant mixed bituminous pavement; OGFC is open-graded friction course.

Other tests were performed on the materials to provide a basis for comparison to existing test methods. These included asphalt content by nuclear gage, and by chemical extraction (centrifuge and reflux). Aggregate gradations were measured on the original aggregate samples and on the aggregate obtained from each of the test methods that yielded clean aggregate. A summary of the tests performed in this experiment is shown in Table 5.

Table 5. Summary of Test Methods and Number of Tests.

Test Description	Method	No. of Tests/Mix
AC by ignition*	See Appendix I	3
AC by nuclear gage	ASTM D 4125/AASHTO T 287	3
AC by extraction:		
centrifuge*	ASTM D 2172/AASHTO T 164 [A]	1
reflux*	ASTM D 2172/AASHTO T 164 [B]	2
gradation	ASTM C 136/AASHTO T 27	2

*Gradations were performed on each of these aggregate samples.

Examination of the initial results from testing the first three mixes revealed several trends that were important in evaluating the results. Several of the labs had never performed the test prior to conducting tests on Mix 1. It was believed this factor influenced the observed variation. Mix 2 was made using a caliche aggregate that is known to be soft and friable relative to other harder rock materials used in PMBP. It was also clear that the automated ignition furnace, Troxler 4155 in this experiment, reported much higher weight loss for the caliche mix. This was because the operator did not control the time or temperature of the test. These results indicate that this aggregate—when burned at a higher temperature—exhibits greater weight loss than the other aggregates tested. Because of these facts, the original experiment was expanded to include Mixes 4 and 5.

Results

Asphalt Content by Ignition Test

The tables in Appendix II summarize the test results obtained in the experiment. Standard deviations and coefficients of variation were computed following procedures outlined in ASTM C 802, results are shown in Table 6. This table presents the results computed for all five mixes. A second set was computed for Mixes 2, 3, and 5, because Mixes 1 and 4 were both production mixes produced in two different batch plants and sampled from a single truck. The variability exhibited

was noticed to be higher than that seen in the other mixes. This was probably due to the sampling method used or variability inherent in an urban batch plant that changes mixes several times a day. It was not believed to be representative of variation in the ignition test method itself. The data in Table 6 show these differences and they are not large. The results computed from Mixes 2, 3, and 5 are believed to be more representative of the ignition test method variability.

The precision statement used for ASTM test methods is expressed as the within-laboratory standard deviation (or coefficient of variation) and between laboratory standard deviation (or coefficient of variation). The 1s (or one standard deviation) was computed following ASTM C 802 procedures. These precision characteristics are single operator precision (repeatability) and multi-laboratory precision (reproducibility).

The d2s value is equal to 2.828 (2 times the square root of 2) multiplied by the 1s value per ASTM C 802. The logic is that two test results from the same material will differ by less than the d2s value 95 percent of the time. Two test results conducted in the same laboratory must differ by the d2s within laboratory value in order to be considered different. Two test results obtained in two different laboratories must differ by the d2s between laboratories to be considered different. Thus, from Table 6 the 1s within-laboratory value for asphalt content is 0.18, and the d2s is 0.51 (2.828 times 0.18) (Table 6). A single test result cannot be concluded to be different from another single test result unless the difference exceeds 0.51 percent. The present NMSHTD specification for asphalt content requires the measured value to be within ± 0.3 percent of the specified amount.

Another question of interest in regard to aggregates is whether there is evidence of aggregate breakdown in the ignition test. In Table 6 the results of gradation data for the 0.75 mm (No. 200), 0.425 mm (No. 40) and 2.00 mm (No. 10) sieves are also shown. There is a concern that aggregate samples obtained from the ignition test cannot be used for gradation testing because the aggregate breaks down during the test and the gradation changes. In the procedures used for this experiment, technicians were asked to assess whether they could observe aggregate breakdown when the test was complete. Three labs reported visible aggregate breakdown on samples of Mix 2, the caliche aggregate. The gradation data are plotted in Figures 1 through 5, which show the mean and specification gradations for each mix.

Table 6. Results of Round-Robin Testing

Average	Std. Deviation (1s)		Coef. of Variation		d2s	
	w/n Lab	Btwn Labs	w/n Lab	Btwn Labs	w/n Lab	Btwn Labs
All Mixes: AC (%):						
5.3	0.22	0.28	4.15	5.28	0.62	0.79
Mix 2, 3, 5 AC (%):						
5.8	0.18	0.25	3.08	4.21	0.51	0.71
All Mixes No. 200 (%):						
5.3	0.49	0.65	9.28	12.23	1.39	1.83
Mix 2, 3, 5 No. 200 (%):						
5.2	0.30	0.53	5.90	10.33	0.86	1.51
All Mixes < No. 40 (%):						
14.7	0.80	0.94	5.46	6.41	2.26	2.66
Mix 2, 3, 5 < No. 40 (%):						
12.1	0.52	0.67	4.26	5.50	1.46	1.89
All Mixes < No. 10 (%):						
28.8	1.78	2.15	6.22	7.47	5.03	6.08
Mix 2, 3, 5 < No. 10 (%):						
24.8	1.52	1.95	6.13	7.89	4.30	5.52

The 1s and d2s values for the three sieves evaluated are shown in Table 6. If the d2s values are compared to the specification tolerances, the results indicate that gradation tests on these samples can be used for assessing specification compliance. Comparing the results shown in Appendix II and as plotted in Figures 1 through 5, there appear to be only small changes in percent passing on some sieves, which does not appear to be significant. These data are also shown in Table 7 for comparison. The data indicate that for the samples tested, the ignition test samples are all within the tolerances normally used in NMSHTD specifications.

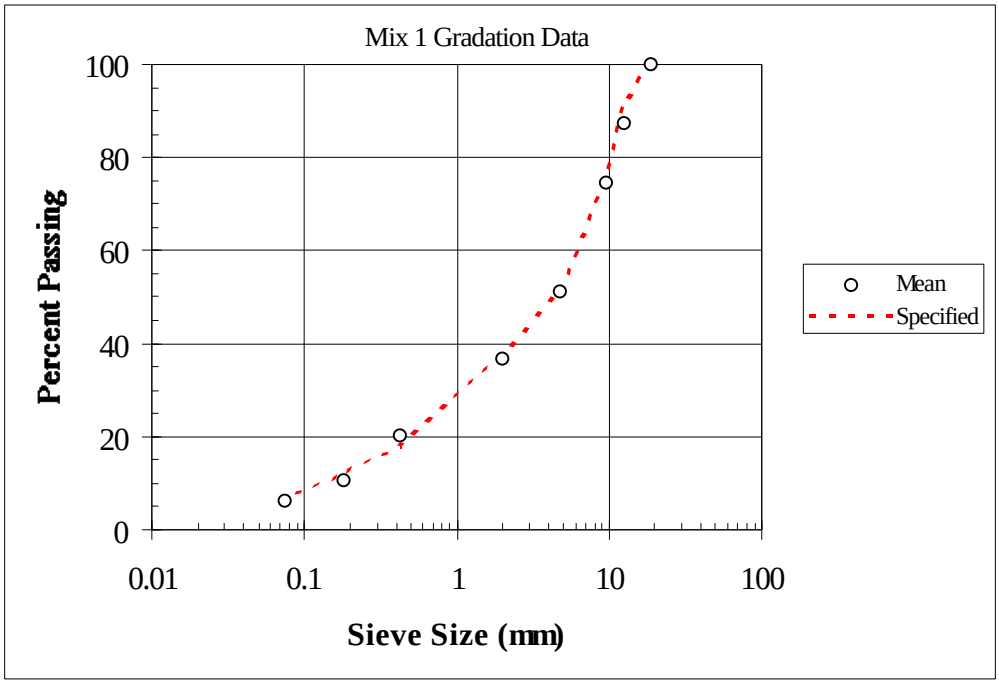

Figure 1. Gradation Data for Mix 1.

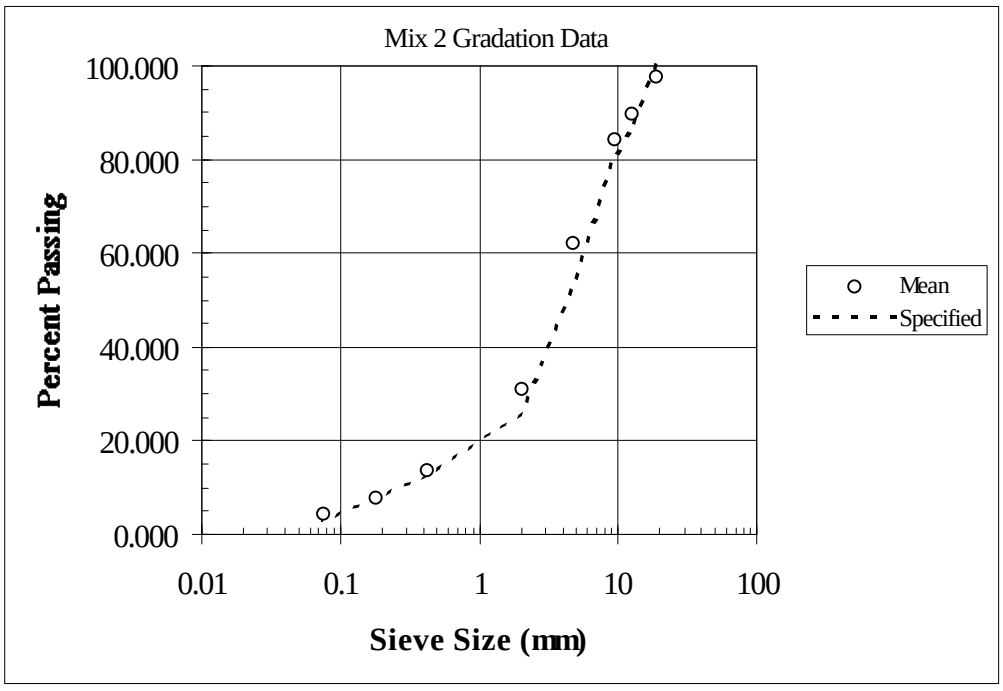

Figure 2. Gradation Data for Mix 2.

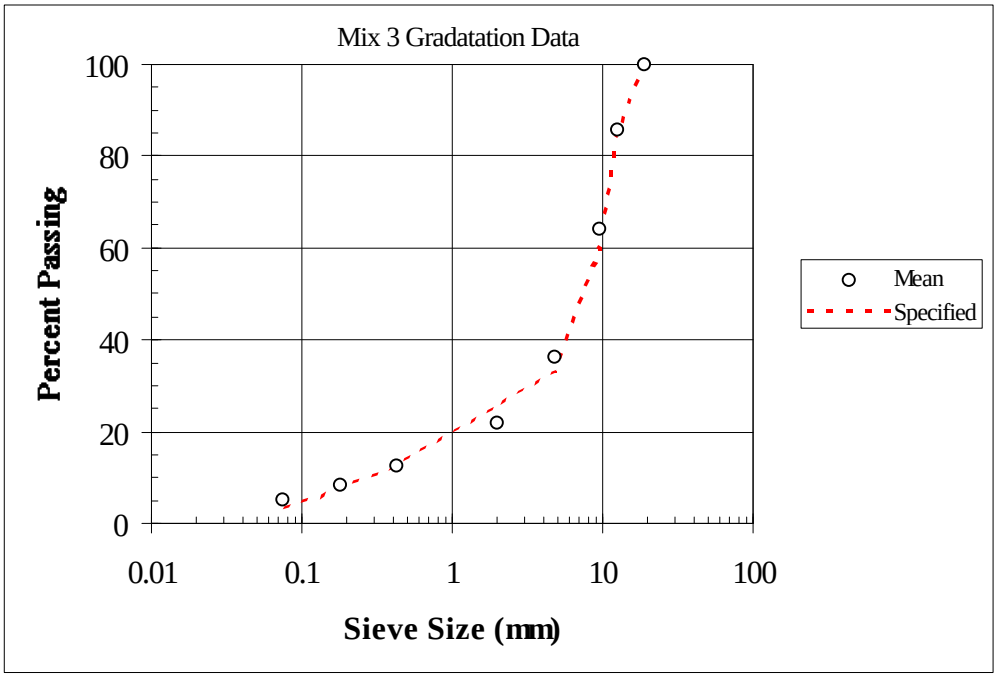

Figure 3. Gradation Data for Mix 3.

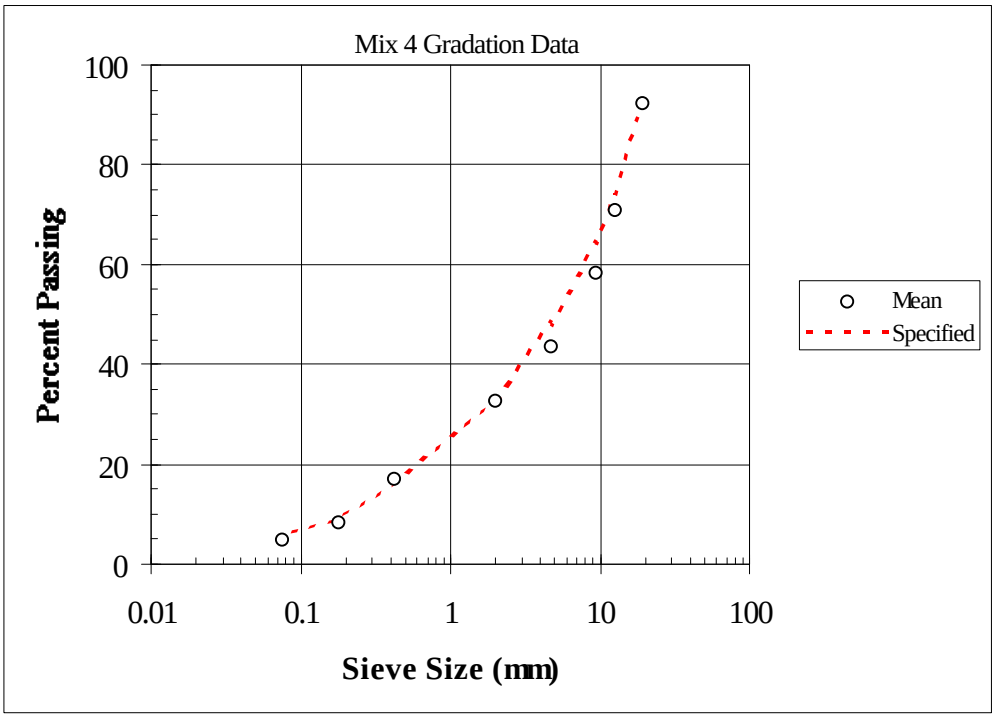

Figure 4. Gradation Data for Mix 4.

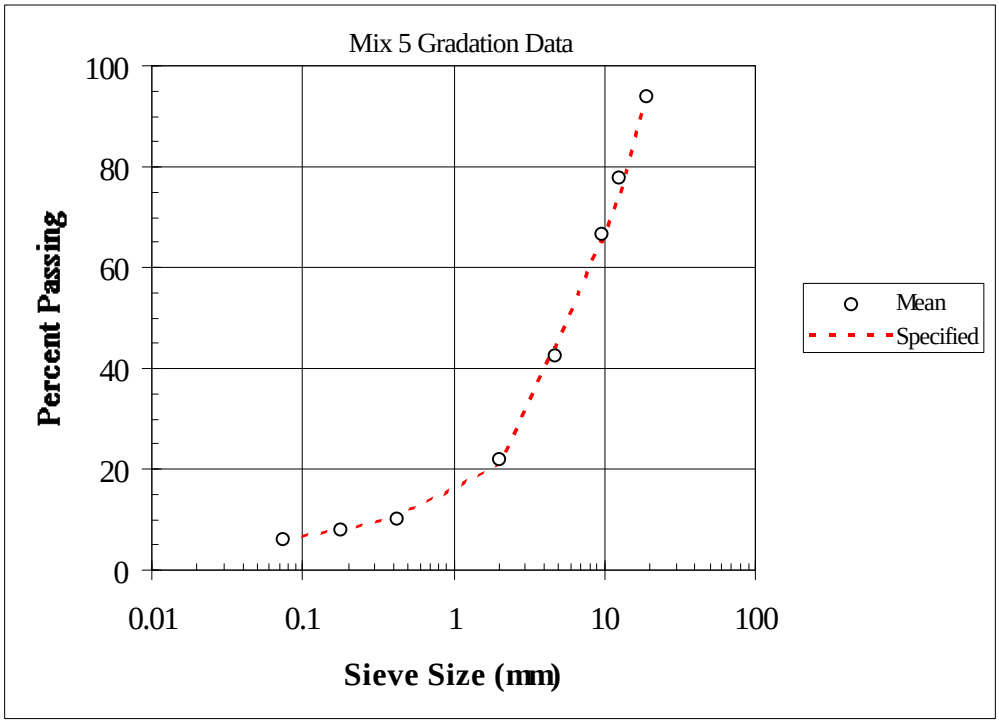

Figure 5. Gradation Data for Mix 5.

Table 7. Comparison of Mean of 10 Laboratories and Specification.

Sieve Size	Specification					Measured Mean					(Spec. - Mean)
mm (in.)	1	2	3	4	5	1	2	3	4	5	Average Diff.
19 (3/4)	100	100	100	93	94	100	98	100	92	94	0.6
12.5 (1/2)	92	85	87	74	74	87	90	86	71	78	3.2
9.5 (3/8)	76	60	81	64	65	75	84	64	58	67	5.8
4.75 (#4)	51	33	53	48	44	51	62	36	44	43	6.2
2.00 (#10)	38	26	26	33	21	37	31	22	33	22	7.2
0.425 (#40)	18	13	13	16	11	21	14	12	17	10	2.2
0.180 (#80)	12	--	8	8	8	12	--	9	9	8	
0.075 (#200)	6.4	3.1	3.1	5.9	6	6.0	4.3	5.2	4.9	5.9	0.96

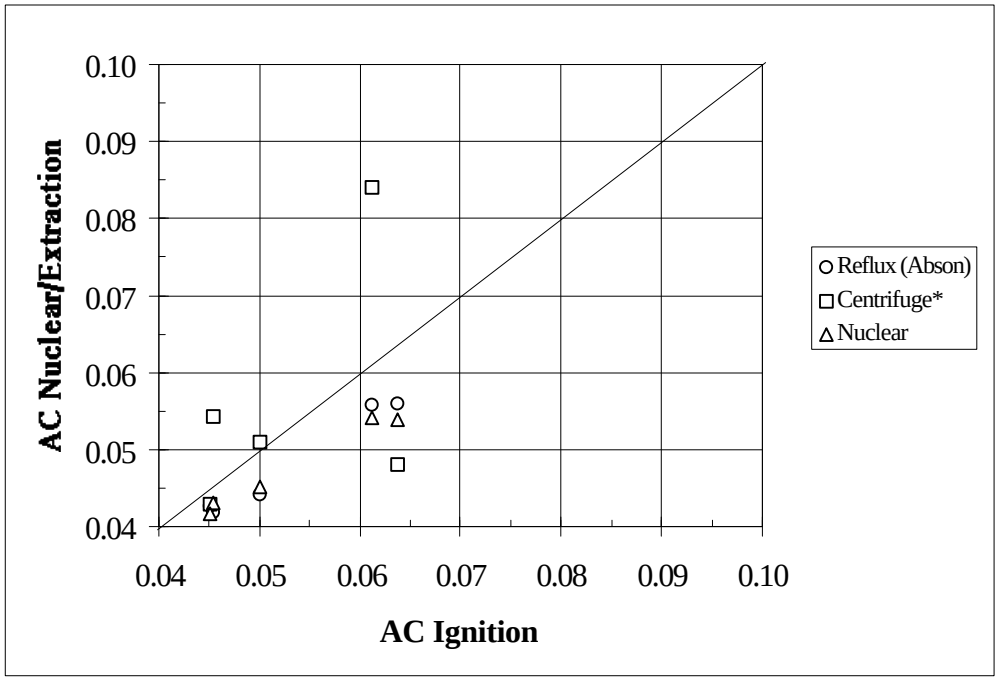

Figure 6. Comparison of Ignition and Other Test Methods.

Figure 6 shows ignition test asphalt content plotted versus nuclear asphalt gage, and extraction by centrifuge and reflux. The results for centrifuge are not very consistent. This variability is considered one of the drawbacks to the centrifuge method of determining asphalt contents. These test results represent a single determination performed in a production laboratory. The nuclear and reflux results are, in contrast, consistent and slightly below the values obtained from the ignition test, which means (1) the present definition of asphalt content (from reflux or nuclear) appear to be consistent and (2) they are both lower than the asphalt content measured in the ignition furnace. This is not unexpected. Portions of the aggregate break down during exposure to the high temperatures in the ignition oven, which is measured as weight loss and equated to asphalt content in this test. The difference varies from roughly 0.3 percent at 4.0 percent asphalt content to 0.5 percent at 6.2 percent asphalt content. This difference is large enough and consistent enough that a correction is essential.

The correction should be determined in the same manner as that used for the calibration of nuclear asphalt content gages. Samples should be tested without asphalt cement, then tested at the design asphalt content and at the design ± 0.5 percent. These data may then be used to determine the increment of asphalt content that must be subtracted from the ignition test apparatus to compensate for weight loss that is not due to combustion of asphalt cement.

Recommendations

It is recommended that the ignition test for asphalt cement content should be implemented immediately for routine use on NMSHTD projects that require asphalt content determinations. The test procedure as outlined in Appendix I should be used in a two-step procedure. First, the incremental burning outlined in the Appendix I procedure should be used to test a minimum of three calibration samples (design asphalt content and ± 0.5 percent). These tests will yield a calibration factor and a time required to burn all the binder. Once these tests are completed, the technicians may then burn for the required time period without incremental measurements. The weight loss obtained must then be adjusted by the calibration factor. It is recommended that the calibration procedure be conducted prior to any production testing and at any time during the production work when a change of aggregate or asphalt cement occurs.

When a standard test procedure is approved by the AASHTO the requirements of that test should be reviewed in comparison to this test procedure. The purpose is to determine whether any modifications to the New Mexico method are warranted.

Precision and Bias

Based on the test data reported, the precision statement in Table 8 is recommended.

Data obtained in this experiment demonstrate that the ignition test has a bias toward an increased asphalt content when compared to nuclear asphalt gages and reflux extractions. Therefore, calibration is required for routine project use of the method.

Table 8. Recommended Test Precision.

Test and Type Index:	Standard Deviation (1s), %	Acceptable Range of of Two Test Results (d2s), %
Single-operator precision*	0.18	0.51
Multilaboratory precision*	0.25	0.71

*These precision statements are based on 5 mixtures, 3 replicates, and 10 laboratories using 9 ignition ovens without internal balances, 1 with an internal balance.

References

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APPENDIX I

TEST PROCEDURE

ATR Institute, University of New Mexico

ASPHALT CONTENT BY IGNITION

Oven Mfg:		Sample#:	
Model No.:		Source:	
Serial No.:		Project:	

1) Wt. of Sample + Basket Before Ignition @ 149 C (300 F), g	
2) Tare Wt. Of Basket @ 149 C (300 F), g	
3) Wt. of Sample Before Ignition @ 149 C (300 F), g [#1 - #2]	
4) Calculate 0.02 % of Initial Sample Wt. (0.02*#3/100)	
****1st Burn 45 min. @ 538 C (1000 F)****	
5) Wt. of Sample + Basket After 1st Burn @ 149 C (300 F), g	
6) Wt. Sample After 1st Burn @ 149 C (300 F), g [#5 - #2]	
****2nd Burn 15 min. @ 538 C (1000 F)****	
7) Wt. of Sample + Basket After 2nd Burn @ 149 C (300 F), g	
8) Wt. of Sample After 2nd Burn @ 149 C (300 F), g [#7 - #2]	
9) Difference Between Wt. After 1st & 2nd Burns, g [#6 - #8]	
10) If #9 < #4 Proceed to #14, If Not Perform 11 thru 12 Until It Is	
****Next Burn 15 min. @ 538 C (1000 F)****	
11) Wt. of Sample + Basket After Next Burn @ 149 C (300 F), g	
12) Wt. of Sample After Next Burn @ 149 C (300 F), g	
13) Difference Between Wt. After Last Two Burns, g [#8 - #12]	
14) Total Wt. Loss @ 149 C (300 F) After Ignition, g	
15) Asphalt Content (% Original Wt.), % [(#14/#3)*100]	

ATR Institute, University of New Mexico

GRADATION DATA

16) Sample Dry Wt. Before Wash @ Room Temp. _____

17) Sample Dry Wt. After Wash @ Room Temp. _____

18) %-No. 200 (75µm) loss ((#16)-(#17)/(#16)*(100)

SIEVE SIZE	CUM. WT.		% Retained	% Pass	Spec.
2 in. (50 mm)					
1 1/2 in. (37.5 mm)					
1 in. (25.0 mm)					
3/4 in. (19.0 mm)					
1/2 in. (12.5 mm)					
3/8 in. (9.5 mm)					
No. 4 (4.75 mm)					
No. 10 (2.0 mm)					
No. 40. (425 µm)					
No. 80 (180 µm)					
No. 200 (75 µm)					
Pan Wt.					
Miscellaneous Data					

Remarks:

Tested By: _____ Date: _____

Reported By: _____ Date: _____

APPENDIX II

SUMMARY OF TEST RESULTS

Table II-1. Mix 1: 60/70, S&G, B Grading.

			Gradation										
	Sieve, in.	**AC**	**3/4**	**1/2**	**3/8**	**#4**	**#10**	**#40**	**#80**	**#200**	**AC**	**Range**	**n**
	Sieve, mm		**19**	**12.5**	**9.5**	**4.75**	**2**	**0.425**	**0.18**	**0.075**	**Stdev**	**(%)**	
1	Dist 1	0.044	100	86	73	50	36	19	10	5.8	0.00230	0.09839	3
2	Dist 2	0.046	100	87	75	52	38	21	12	6.2	0.00291	0.12563	3
3	Dist 3	0.043	100	84	71	49	35	19	10	5.9	0.00333	0.15114	3
4	Dist 4	0.046	100	89	79	55	38	21	10	5.1	0.00121	0.05067	3
5	Dist 5	0.044	100	88	73	50	35	20	10	5.9	0.00027	0.01225	3
6	Dist 6	0.044	100	87	74	50	36	20	11	6.2	0.00251	0.11235	3
7	HQG1	0.047	100	89	79	55	39	21	11	6.5	0.00166	0.06892	3
8	BCPWD	0.047	100	86	74	52	37	20	10	5.7	0.00145	0.06144	3
9	ACNM	0.046	100	89	75	52	37	21	11	6.4	0.00136	0.05862	3
10	WM	0.045	100	87	72	49	36	20	11	6.6	0.00500	0.19708	3
	Mean	**0.045**	**100**	**87**	**75**	**51**	**37**	**20**	**11**	**6.0**			
	Stdev	0.00146	0.000	1.644	2.645	2.190	1.458	0.691	0.652	0.447			
	Reflux (Abson)	0.042	100	88	78	51	37	20	**12.5**	5.4	0.00113	0.00160	2
	Centrifuge*	0.054	100	89	79	55	38	21	10	5.1			1
	Nuclear	0.043	---	---	---	---	---	---	---	---	0.00439	0.00760	3
	Specified	**0.042**	**100**	**92**	**76**	**51**	**38**	**18**	12.2	**6.4**			
	Spec. Tolerance	± 0.003	± 6	± 6	± 6	± 6	± 6	± 4	---	± 2			
	(Spec) - (Mean)	-0.003	0	5	1	0	1	-2	---	0.4			

*No ash correction for the centrifuge/ WM Troxler weighed with internal balance/1.5% Lime

Table II-2. Mix 2: PAC 40, Caliche, B Grading.

Lab	Sieve, in.	AC	Gradation								AC	Range	n
	Sieve, mm		3/4	1/2	3/8	#4	#10	#40	#80	#200	Stdev	(%)	
			19	12.5	9.5	4.75	2	0.425	0.18	0.075			
1	Dist 1	0.063	98	89	85	64	32	14	8	4.7	0.00170	0.05365	3
2	Dist 2	0.062	97	90	86	63	33	14	9	4.8	0.00158	0.05060	3
3	Dist 3	0.061	99	92	86	64	31	14	8	4.6	0.00206	0.06325	3
4	Dist 4	0.061	97	90	85	62	31	15	9	5.3	0.00245	0.08051	3
5	Dist 5	0.064	97	89	84	61	29	12	7	3.6	0.00170	0.05021	3
6	Dist 6	0.066	97	90	84	62	32	13	8	4.0	0.00459	0.13959	3
7	HQ G1	0.062	98	90	84	61	31	14	9	4.9	0.00158	0.04616	3
8	BCPWD	0.062	98	88	82	60	32	14	8	3.9	0.00025	0.00804	3
9	ACNM	0.063	98	89	84	61	30	13	7	3.8	0.00075	0.02262	3
10	WM	0.072	96	89	84	63	31	13	7	3.2	0.00150	0.04161	3
	Mean	**0.064**	**98**	**90**	**84**	**62**	**31**	**14**	**8**	**4.3**			
	Stdev	0.003	0.832	1.143	1.220	1.297	1.196	0.768	0.842	0.671			
	Reflux (Abson)	0.056	100	87	81	53	26	13	---	3.1	0.00092	0.00130	2
	Centrifuge*	0.048	94	83	78	54	26	12	6	2.8			1
	Nuclear	0.054	---	---	---	---	---	---	---	---	0.00070	0.00140	3
	Specified	**0.055**	**100**	**87**	**81**	**53**	**26**	**13**	7.8	**3.1**			
	Tolerance	± 0.003	± 6	± 6	± 6	± 6	± 6	± 4	---	± 2			
	(Spec) - (Mean)	-0.009	2	-3	-4	-10	-5	-1	---	-1.2			

*No ash correction for the centrifuge/ WM Troxler weighed with internal balance/No Lime

Table II-3. Mix 3: AC 10, S&G, B Grading.

Lab	Sieve, in.	AC	Gradation								AC	Range	n
	Sieve, mm		3/4	1/2	3/8	#4	#10	#40	#80	#200	Stdev	(%)	
			19	12.5	9.5	4.75	2	0.425	0.18	0.075			
1	Dist 1	0.050	100	84	62	34	21	12	8	5.4	0.00074	0.02992	3
2	Dist 2	0.049	100	89	67	36	21	12	8	5.2	0.00189	0.06814	3
3	Dist 3	0.050	100	87	66	37	22	12	9	5.3	0.00101	0.03579	3
4	Dist 4	0.049	100	88	65	36	22	13	9	5.6	0.00182	0.07320	3
5	Dist 5	0.049	100	86	61	35	21	12	8	5.1	0.00133	0.05397	3
6	Dist 6	0.051	100	87	66	37	23	13	9	5.3	0.00025	0.00971	3
7	HQ G1	0.053	100	85	62	35	22	12	8	4.8	0.00115	0.04332	3
8	BCPWD	0.051	100	87	68	39	23	13	9	5.2	0.00136	0.04683	3
9	ACNM	0.049	100	83	62	34	22	13	8	5.2	0.00014	0.00505	3
10	WM	0.050	100	83	63	37	23	13	9	5.3	0.00153	0.05752	3
	Mean	0.050	**100**	**86**	**64**	**36**	**22**	**12**	**9**	**5.2**			
	Stdev	0.00109	0	1.941	2.362	1.459	0.760	0.346	0.297	0.228			
	Reflux (Abson)	0.04425	100	81	59	33	21	12	---	6.5	0.00049	0.00070	2
	Centrifuge*	0.051	100	86	64	36	22	12	8	4.9			1
	Nuclear	0.045	---	---	---	---	---	---	---	---	0.00067	0.00120	3
	Specified	0.047	**100**	**85**	**60**	**33**	**26**	**13**	7.8	**3.1**			
	Tolerance	± 0.003	± 6	± 6	± 6	± 6	± 6	± 4	ó	± 2			
	(Spec) - (Mean)	-0.003	0	-1	-4	-3	4	0		-2			

*No ash correction for the centrifuge/ WM Troxler weighed with internal balance/No Lime

Table II-4. Mix 4: 60/70, S&G, A Grading.

Lab	Sieve, in.	AC	Gradation								AC	Range	n
	Sieve, mm		3/4	1/2	3/8	#4	#10	#40	#80	#200	Stdev	(%)	
			19	12.5	9.5	4.75	2	0.425	0.18	0.075			
1	Dist 1	0.043	91	68	57	42	31	16	8	5.0	0.00061	0.02750	3
2	Dist 2	0.043	92	70	57	42	32	17	8	4.8	0.00373	0.16900	3
3	Dist 3	0.048	94	75	63	48	36	18	9	5.0	0.00065	0.02632	3
4	Dist 4	0.046	94	72	60	48	35	19	9	5.5	0.00219	0.09123	3
5	Dist 5	0.050	92	73	59	44	33	17	8	4.8	0.00502	0.19167	3
6	Dist 6	0.044	91	72	58	42	32	17	9	5.0	0.00232	0.09883	3
7	HQ G1	0.042	93	67	55	41	31	16	8	4.9	0.00629	0.28497	3
8	BCPWD	0.047	92	72	61	46	34	18	8	5.1	0.00030	0.01291	3
9	ACNM	0.043	92	70	57	41	31	17	9	5.3	0.00082	0.03724	3
10	WM	0.044	92	68	55	41	31	15	7	3.2	0.00222	0.09354	3
	Mean	0.045	**92**	**71**	**58**	**44**	**33**	**17**	**8**	**4.9**			
	Stdev	0.00259	0.968	2.444	2.601	2.819	1.758	1.063	0.567	0.619			
	Reflux (Abson)	0.043	91	70	59	43	32	17	10	6.3	0.00226	0.00320	2
	Centrifuge*	0.043	92	77	64	48	35	17	7	3.1			1
	Nuclear	0.041	---	---	---	---	---	---	---	---	0.00115	0.00230	3
	Specified	0.040	**93**	**74**	**64**	**48**	**33**	**16**	**9**	**5.9**			
	Tolerance	± 0.003	± 6	± 6	± 6	± 6	± 6	± 4	ó	± 2			
	(Spec) - (Mean)	-0.005	1	3	6	4	0	-1	---	1			

*No ash correction for the centrifuge/ WM Troxler weighed with internal balance/1.5 % Lime

Table II-5. Mix 5: PG58-28, Basalt S III Grading.

			Gradation										
Lab	**Sieve, in.**	**AC**	**3/4**	**1/2**	**3/8**	**#4**	**#10**	**#40**	**#80**	**#200**	**AC**	**Range**	**n**
	Sieve, mm		**19**	**12.5**	**9.5**	**4.75**	**2**	**0.425**	**0.18**	**0.075**	**Stdev**	**(%)**	
1	Dist 1	0.060	96	79	67	43	22	11	8	6.4	0.00032	0.01006	3
2	Dist 2	0.060	95	77	66	42	22	11	8	5.8	0.00292	0.09085	3
3	Dist 3	0.061	95	79	67	43	22	10	8	5.6	0.00057	0.01870	3
4	Dist 4	0.061	94	77	67	42	22	11	8	6.3	0.00092	0.02984	3
5	Dist 5	0.061	92	76	63	41	21	10	8	5.6	0.00045	0.01475	3
6	Dist 6	0.063	94	80	69	44	23	10	8	6.1	0.00244	0.07083	3
7	HQG1	0.060	93	75	64	41	22	10	8	6.0	0.00298	0.09429	3
8	BCPWD	0.062	96	81	69	45	22	10	8	5.9	0.00083	0.02651	3
9	ACNM	0.062	92	76	65	43	22	11	8	6.6	0.00092	0.02962	3
10	WM	0.062	94	80	69	44	21	10	7	5.2	0.00172	0.04995	3
	Mean	0.061	**94**	**78**	**67**	**43**	**22**	**10**	**8**	**5.9**			
	Stdev	0.00112	1.452	2.071	2.106	1.456	0.599	0.406	0.406	0.427			
	Reflux (Abson)	0.056	98	84	70	45	24	12	11	9.0	0.00000	0.00000	2
	Centrifuge*	0.084	99	88	76	48	21	8	5	3.4			1
	Nuclear	0.054	---	---	---	---	---	---	---	---	0.00081	0.00160	3
	Specified	0.052	**94**	**74**	**65**	**44**	**21**	**10.5**	**8**	**6**	(interpolated/superpave)		
	Tolerance	± 0.003	± 6	± 6	± 6	± 6	± 6	± 4	ó	± 2			
	(Spec) - (Mean)	-0.009	0	-4	-2	1	-1	0	---	0			

*No ash correction for the centrifuge/ WM Troxler weighed with internal balance/1.5 % Lime