MARTCP

Training/ Qualification Program

Hot Mix Asphalt

Plant Technician

Level I

Sampling & Testing at the Plant Site

Page 8-1

1

- The primary focus of this manual is quality control, since sampling and testing at an HMA facility is generally the responsibility of the contractor.
- Most quality assurance sampling and testing is conducted on materials obtained from the paving site / behind the paver.

2

Sampling & Testing at the Plant Site (AASHTO)

T2 - Sampling of Aggregates

T40 - Sampling Bituminous Materials

T168 - Sampling HMA Paving Mixtures

T312 - Density by Means of Gyratory Compactor

T11- Material Finer than #200 Sieve

T27 - Sieve Analysis of Fine and Coarse Aggregate

Page 8-1

3

Sampling & Testing at the Plant Site (AASHTO)

T30 - Mechanical Analysis of Extracted Aggregate

T166 - BSG of Compacted HMA Mixtures

T209 - MSG of HMA Mixtures

T248 - Reducing Samples of Agg to Testing Size

T164 / T287 / T308 - Asphalt Content Determination

Page 8-2

4

Validity of Sample Data

Obtaining Valid Samples Is Not Automatic

Page 8-2

5

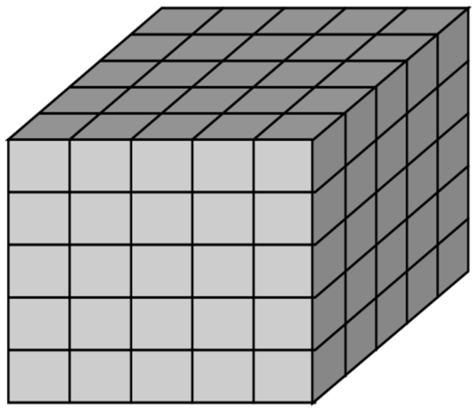
Statistics

- Science that deals with the treatment and analysis of numerical data
- IT'S A TOOL

Page 8-3

6

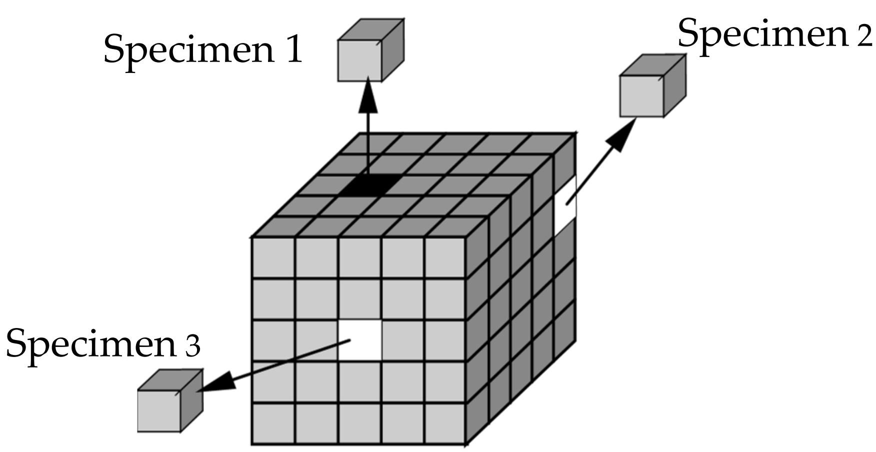
Lot



Page 8-3

7

Sample from a Lot



Page 8-4

8

The Myth of Single Sample

- The belief that the test results from a single sample shows the "true" quality of the material is FALSE
- Nature dislikes uniformity; variation is the rule
- Sampling must account for variability
- Multiple sampling helps

Page 8-4

9

Random Sampling

- Random Sampling is a sampling procedure where any specimen in the population has an equal chance of being sampled.
- Sample is selected without bias

Page 8-4

10

Random Sampling of Construction Materials (ASTM D3665)

Page 8-4

11

Random Number Tables

The most common method for determining when or where to obtain samples is through the use of a random number table

ASTM 3665

0.74	0.60	0.01	0.27
0.29	0.21	0.78	0.01
0.28	0.37	0.00	0.49
0.73	0.08	0.87	0.32
0.72	0.14	0.09	0.70

Page 8-5

12

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0.73	0.08	0.87	0.32
0.72	0.14	0.09	0.70

Page 8-5

13

Random Calculation Formula

RN : Random Number

Sample Location = Start (location) + (RN x total length)

Sample Time = Start (time) + (RN x total time)

Sample Tonnage = Start (tonnage) + (RN x total tonnage)

14

Random Sampling (example)

Assume: Lot = 1 day's production (1200 tons)
4 samples, start @ tonnage = 0

Determine: sample locations

Random numbers = 0.74, 0.29, 0.28, 0.73

Page 8-6

15

Random Number Tables

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0.74	0.60	0.01	0.27
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0.72	0.14	0.09	0.70

Page 8-5

16

Random Sampling (example)

Start (tonnage) + (RN x total tonnage) = Sample Tonnage

Sample 1: 0 + (**0.74** x 1200 tons) = 888 tons

Sample 2: 0 + (**0.29** x 1200 tons) = 348 tons

Sample 3: 0 + (**0.28** x 1200 tons) = 336 tons

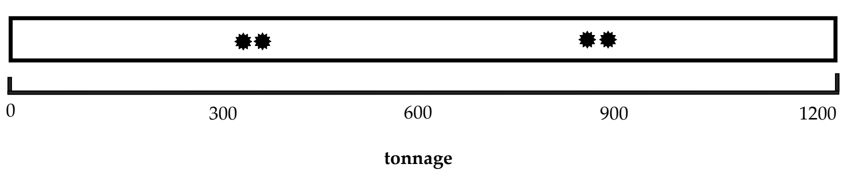
Sample 4: 0 + (**0.73** x 1200 tons) = 876 tons

Page 8-6

17

Random Sampling

One Day's Production = 1200 tons



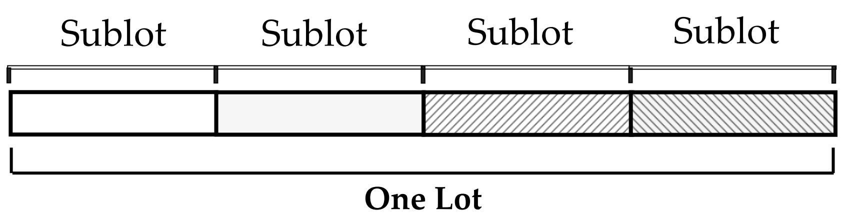
How Do We Prevent This?

Page 8-7

18

Stratified Random Sampling

Divide & Conquer



Page 8-7

19

Example #1 (Stratified Random)

Given: - Lot = 1 days production = 1200 tons

- 1200 tons/day, 4 samples/lot.

- Starting at 0 tons

- RN = 0.74, 0.29, 0.28, 0.73

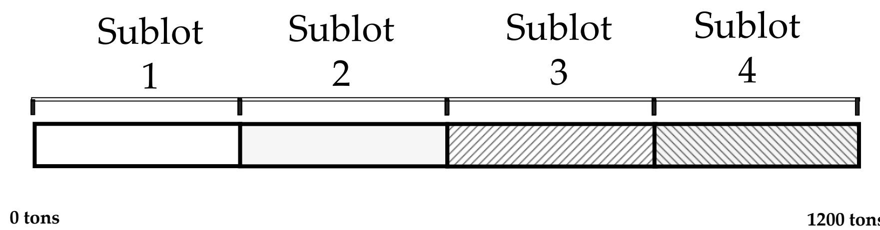
Find: Tonnage for each sample using stratified random sampling.

Page 8-7

20

Example #1 (Stratified Random) con't.

One Day's Production = 1200 tons / 4 Sublots



Page 8-7

21

Example #1 (Stratified Random) con't.

Sublot size: 1200 tons / 4 sublots = 300 tons

Our 1st sublot starts at 0 tons

Sublot 1: 0 – 300 tons

Sublot 2: 300 tons – 600 tons

Sublot 3: 600 tons – 900 tons

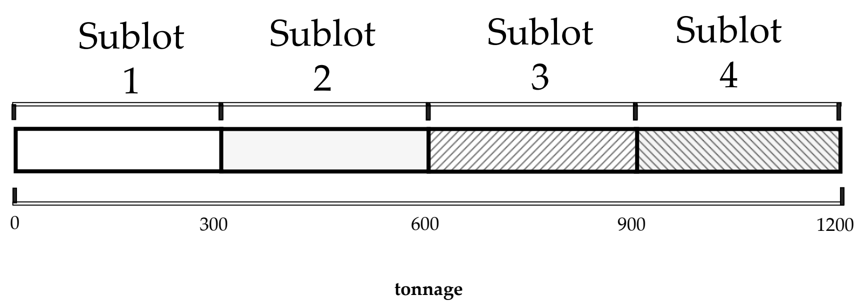
Sublot 4: 900 tons – 1200 tons

Page 8-7

22

Example #1 (Stratified Random) con't.

One Day's Production = 10 hours / 4 Sublots



Page 8-7

23

Example #1 (Stratified Random) con't.

1. What is our Lot size?

   Lot size = 1200 tons

2. How many samples do we need?

   4 samples = # of sublots.

3. What is our sublot size?

   Sublot size = Lot size ÷ # of samples = 300 tons

4. When do our sublots start & stop?

Page 8-7

24

Example #1 (Stratified Random) con't.

5. Actual sample location!!

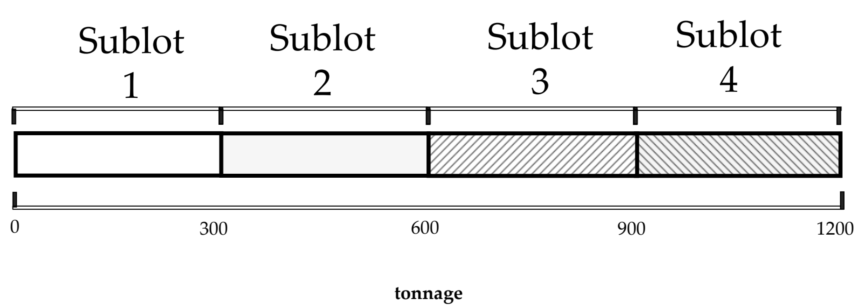
Sublot   Sublot
Sample Tonnage = Start (tons) + (RN x Sublot tons)

Page 8-7

25

Example #1 (Stratified Random) con't.

One Day's Production = 10 hours / 4 Sublots



Page 8-7

26

Example #1 (Stratified Random) con't.

When will our 4 samples be taken?

Our random numbers are: 0.74, 0.29, 0.28 & 0.73

Start (tons) + (RN x sublot tons) = Sublot Tonnage

Sublot 1:

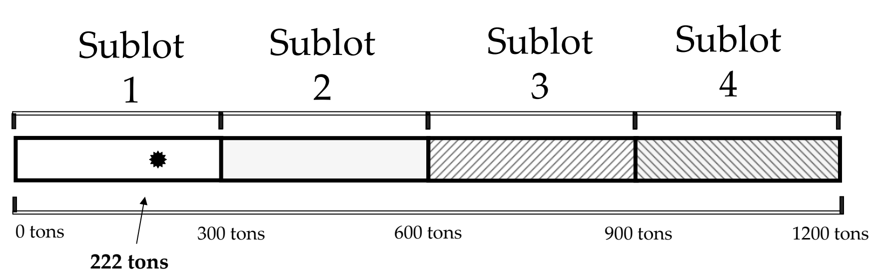
0 tons + (0.74 x 300 tons) = 222 tons

Page 8-7

27

Example #1 (Stratified Random) con't.

One Day's Production = 1200tons / 4 Sublots



Page 8-7

28

Example #1 (Stratified Random) con't.

Sublot Start (tons) + (RN x total sublot tons) = Sublot Sample Tonnage

Sublot 2: 300 tons+ (0.29 x 300 tons) =

300 tons + 87 tons = 387 tons

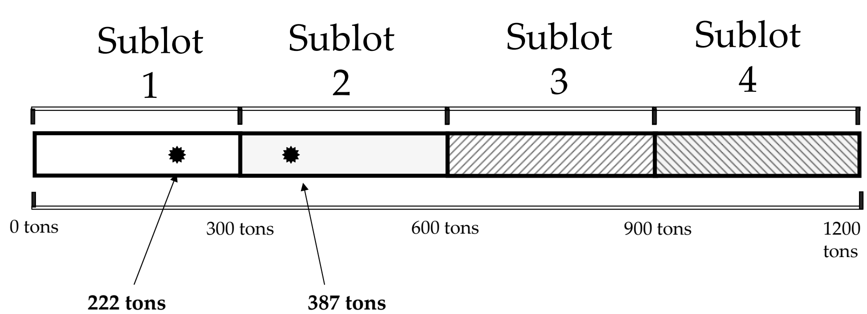
Page 8-7

29

Example #1 (Stratified Random) con't.

Sublot 2

One Day's Production = 1200 tons / 4 Sublots



Page 8-7

30

Example #1 (Stratified Random) con't.

Random numbers = 0.74, 0.29, 0.28, 0.73

Sample # 1 = 222 tons

Sample # 2 = 387 tons

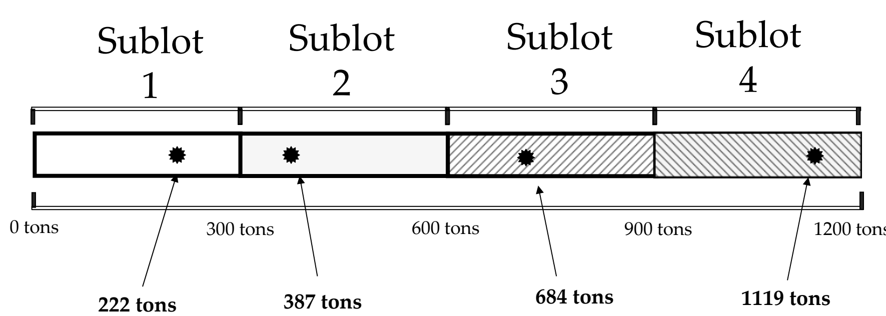
Sample # 3 = 600 tons + (.28 x 300 tons) = 684 tons

Sample # 4 = 900 tons + (.73 x 300 tons) = 1119 tons

Page 8-7

31

Example #1 (Stratified Random) con't.



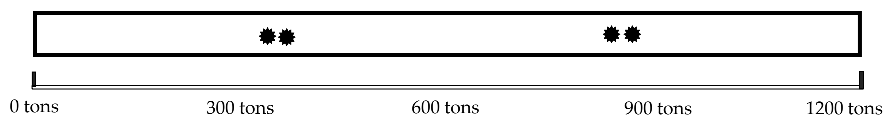
Page 8-7

32

Plain Random Sampling

One Day's Production = 1200 tons

Stratified Random Sampling is Mandatory



Page 8-7

33

Example #2 (Stratified Random)

Using the Stratified Random Sampling Method, Calculate the Sample Locations.

Total daily paving = 1 mile = 5280 feet

Number of samples = 4

0.74	0.60	0.01	0.27
0.29	0.21	0.78	0.01
0.28	0.37	0.00	0.49
0.73	0.08	0.87	0.32
0.72	0.14	0.09	0.70

34

Example #2 (Stratified Random) con't.

1. What is our Lot size? 5280 feet (instead of tons)
2. How many samples do we need? 4 samples
3. What is our sublot size? (Lot size ÷ # of samples)
4. When do our sublots start & stop?
5. Actual sample location!!

Sample Location = Sublot Start (tonnage) + (RN x sublot tonnage)

Sublot Start (tonnage) + (RN x sublot tonnage) = Sample Location

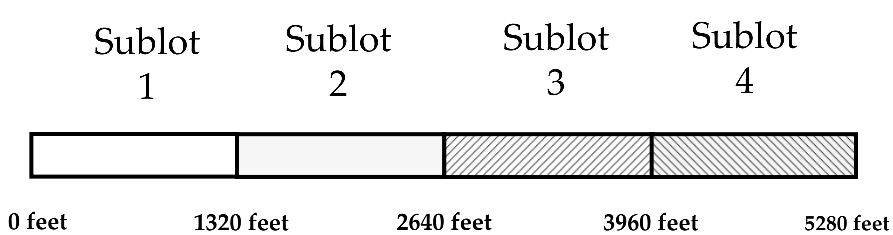
35

Example #2 (Stratified Random) con't.

Total daily paving length = 5280 feet = Lot Size

Number of samples = 4

Sublot Size = 5280 / 4 = 1320 feet



36

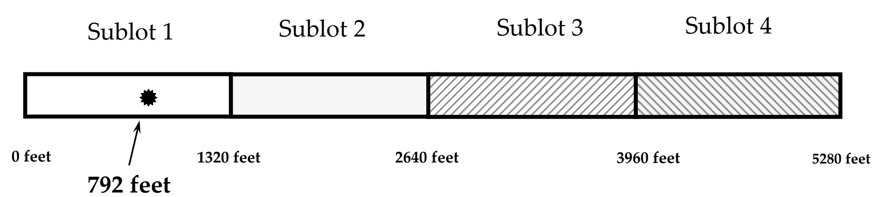
Example #2 (Stratified Random) con't.

When will our 4 samples be taken?

Our random numbers are: 0.60, 0.21, 0.37 & 0.08

Sublot 1: Start (distance) + (RN x total sublot distance) = Sample distance

0 feet + (0.60 x 1320) = 792



37

Example #2 (Stratified Random) con't.

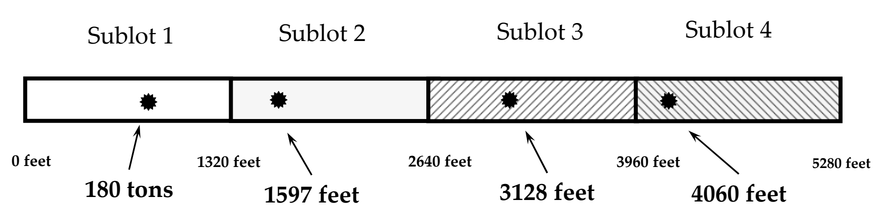
Our random numbers are: 0.60, 0.21, 0.37 & 0.08

Sublot Sample location = Sublot Start (location) + (RN x total sublot distance)

Sublot 2: 1320 feet + (0.21 x 1320 feet) = 1597 feet

Sublot 3: 2640 feet + (0.37 x 1320 feet) = 3128 feet

Sublot 4: 3960 feet + (0.08 x 1320 feet) = 4060 feet



38

Sampling HMA at Facility

39

Sampling HMA at Facility

- Sampling the asphalt mixture is as important as testing it. So the sampler must take every precaution to obtain samples that yield an acceptable estimate of the nature and conditions of the material they represent
- Sample locations and times should be selected randomly
- Use clean containers for the sample
- Obtain 4 to 5 times the material than is needed for a test sample.

40

Sampling HMA at Facility

- Sampling is a key element in a successful quality control program.
- Samples must represent the materials being produced, and must be obtained in a manner in which all material produced have an equal likelihood of being sampled
- Most agencies that use QC programs have detailed procedures for selecting sampling locations and obtaining Samples.
- The QC technician must be aware of the procedures required and use the appropriate methods for the materials being produces.

41

Routine Tests for Facility

- Plant laboratories should be equipped to perform tests that are required daily and weekly, or those which require answers almost immediately in the QC process

Page 8-8

42

Routine Tests for Facility

- Moisture
- Sieve analysis (Gradation)
- Asphalt content (A.C.)
- Max. Gravity (Gmm/MSG) (Rice Test)
- Bulk Gravity (Gmb/BSG) (Plugs)

48

Tests Typically <u>NOT</u> Run at HMA Plant

<u>Aggregate</u>

- LA Abrasion
- Soundness
- Wear Index
- Sand Equivalency
- Plasticity Index

<u>Asphalt Cement (AC)</u>

- Specific Gravity
- Viscosity
- Penetration
- Thin Film Oven Tests
- Ductility
- Flashpoint

Page 8-13

49

Test Repeatability & Reproducibility

- All tests have some error
- The more difficult the test, the greater the possibility of error.
- Most testing errors occurs when the technician attempts to make the test easier or quicker
- Follow established procedures

Page 8-14

50

Job is not Done Until the Paperwork is Done

68

But First, a Message From AASHTO

69

AASHTO - E29

Method of Rounding Numbers

Use the way you learned in High School for rounding except when the number you are rounding is followed by a "5".

91.13 = 91.1	**15.27 = 15.3**
0.0273 = 0.027	**0.0278 = 0.028**

70

AASHTO Rounding Rules

When number to be rounded is an "odd" number (1,3,5,7,9) and is follow by a "5" then round it up !!

When the number to be rounded is an "even" number (0,2,4,6,8) and is followed by a "5" then it stays the same.

71

AASHTO Rounding Examples

Round the Following Numbers to the Nearest Tenth

Odd ↱	
Even ↰	

91.15 = 91.2

91.25 = 91.2

91.55 = 91.6

91.85 = 91.8

91.95 = 92.0

72

Round the Following Numbers

to the Nearest Whole Number

Odd ↱
Even ↰

93.5 = 94

96.5 = 96

To the Nearest Tenth:

94.75 = 94.8

62.45 = 62.4

73

Round the Following Numbers

to the Nearest Hundredth

Odd ↱
Even ↰

56.235 = 56.24

17.885 = 17.88

To the Nearest Thousandth:

2.6345 = 2.634

2.4775 = 2.478

74

Aggregate Gradations

- Aggregate Gradation
  - The distribution of particle sizes expressed as a percent of total weight.
  - Determined by sieve analysis

Page 8-18

75

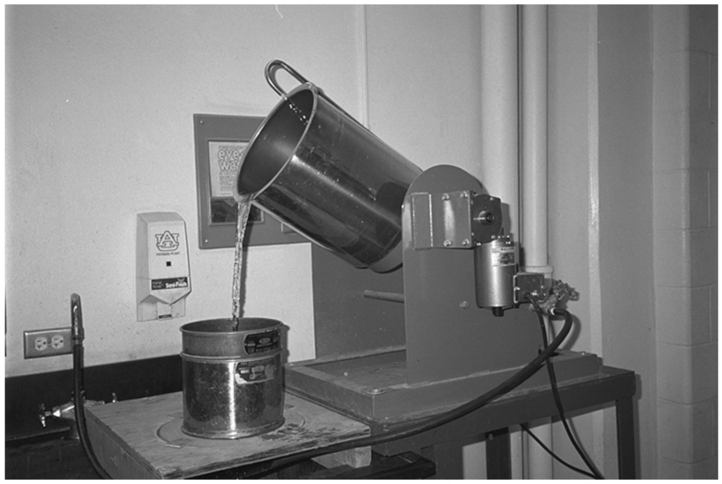
Aggregate Gradation Analysis

- Step 1 - AASHTO T11
  Washed Sieve Analysis
  - Dry aggregate and determine mass
  - Wash and decant water through #200 (0.075 mm) sieve until water is clear
  - Dry aggregate to a constant mass

Page 8-18

76

Aggregate Washer



77

Aggregate Gradation Analysis

Part 2 - AASHTO T27

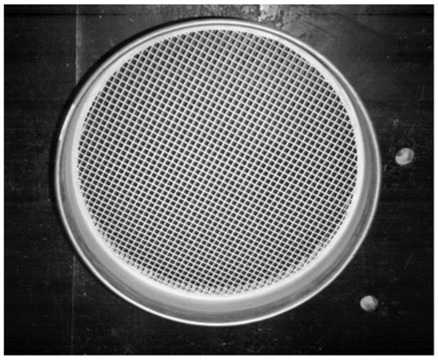
Mechanical sieve analysis

- Place dry aggregate in standard stack of sieves
- Place sieve stack in mechanical shaker
- Determine mass of aggregate retained on each sieve

Page 8-19

78

Mechanical Sieve



Individual Sieve

Stack of Sieves

79

Mechanical Sieve

Stack in
Mechanical
Shaker

80

Gradations - Computing

$$\% \text{ Retained} = \frac{\text{Cum. Wt Retained}}{\text{Original Dry Wt.}} \times 100$$

$$\% \text{ Passing} = \left[1 - \frac{\text{Cum. Wt Retained}}{\text{Original Dry Wt.}} \right] \times 100$$

Page 8-20

81

Gradations - Computation

"Calculate % Passing to the Nearest Tenth(0.0)"

Sieve	Mass Retained	Cumulative Mass Retained	Cumulative % Retained	Cumulative % Passing
9.5	0.0	0.0	0.0	100.0
4.75	6.5	6.5	1.2	98.8
2.36	127.4	133.9	24.8	75.2
1.18	103.4	237.3	44.0	56.0
0.60	72.8	310.1	57.4	42.6
0.30	64.2	374.3	69.4	30.6
0.15	60.0	434.3	80.5	19.5
0.075	83.0	517.3	95.8	4.2
Pan	22.4	539.7	100.0	0.0

T-11 Gradations - Computation
Wash loss = 31.9

Calculate % Passing to the Nearest Whole Number

Sieve	Mass Retained	Cumulative Mass Passing	Cumulative % Passing	
9.5	0.0	559.6	100.0	100
4.75	6.5	553.1	98.8	99
2.36	127.4	425.7	76.1	76
1.18	113.4	312.3	55.8	56
0.60	72.8	239.5	42.8	43
0.30	61.2	178.3	31.9	32
0.15	64.0	114.3	20.4	20
0.075	80.0	34.3	6.1	6
Pan	2.4		0.0	

Gradations - Computation

"Calculate % Passing to the Nearest Tenth(0.0)"

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0.30	64.2	374.3	69.4	30.6
0.15	60.0	434.3	80.5	19.5
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Pan	22.4	539.7	100.0	0.0

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1.18	113.4	312.3	55.8	56
0.60	72.8	239.5	42.8	43
0.30	61.2	178.3	31.9	32
0.15	64.0	114.3	20.4	20
0.075	80.0	34.3	6.1	6
Pan	2.4		0.0	

Asphalt Content by Ignition Oven - AASHTO T308

- Ignition oven heats paving mixture to very high temperature, burning off asphalt binder
- Asphalt content determined from difference in weight before and after ignition
- Simple and accurate
- Allowed by Department for quality control; include in QC plan

Page 8-23

84

Ignition Oven Sample Size AASHTO T308

HMA Mixture	Min. Sample Mass
4.75mm (#4)	1200 grams
9.5mm (3/8″)	1200 grams
12.5mm (1/2″)	1500 grams
19.0mm (3/4″)	2000 grams
25.0mm (1″)	3000 grams
37.5mm (1 1/2″)	4000 grams

Page 8-24

87

Asphalt Content by Ignition Oven Method A Procedure

- Preheat furnace to 540 ^{O}C (1000 ^{O}F)
- Weigh sample, sample tray and catch pan
- Place in furnace
- Heat until change in sample mass does not exceed 0.01 percent
- Determine change in sample mass
- Calculate asphalt content

Page 8-25

88

Asphalt Content by Ignition Oven Method B Procedure

- Preheat oven and determine mass of sample, tray, and catch pan
- Heat sample for 45 minutes, cool and weigh
- Heat sample for another 15 minutes, cool and weigh
- Continue until change in mass is less than 0.01 percent
- Calculate asphalt content

Page 8-25

89

904.04.05 - Plant Control; The following tolerances shall apply:

TABLE 904 C - MIX TOLERANCES

PHYSICAL PROPERTY	TOLERANCE
Passing No. 4(4.75mm) sieve and larger,%	±7(a)
Passing No. 8(2.36mm) thru No. 100(150um) sieve, %	±4
Passing No. 200(75um) sieve, %	±2
Asphalt content, %	±0.4
Ratio of dust to binder material,	0.6 to 1.6 (b)
Mix temperature leaving plant versus design mix temperature, F (C)	±25 (14)
Deviation of maximum specific gravity per lot versus design max.sp.gr.	±0.30
Voids, total mix, (VTM),%	4 ±1.2
Voids, total mix, SR mix (VTM),%	3 ±2
Voids in mineral aggregate,(VMA), %	±1.2 from design target
Voids filled asphalt (VFA),%	Within spec
Bulk specific gravity, $G_{mb,\ \%}$	±0.022
Gmb at N_{max} ,%	±0.5

90

Determine if each sieve size meets the specification.

Indicate YES or NO

SIEVE	MASS PASSING	% PASSING	JMF TARGET	JMF TOLERANCE	MEET SPEC (YES/NO)
3/8″ – 9.5mm	650.1	100	100	100	YES
#4 – 4.75mm	601.3	92.5	88	81 - 95	YES
#8 - 2.36mm	477.8	73.5	76	72 - 80	YES
#16 – 1.18mm	293.2	45.1	51	47 - 55	NO
#30 – 0.60mm	241.2	37.1	36	32 - 40	YES
#50 – 0.30mm	122.2	18.8	20	16 - 24	YES
#100 – 0.15mm	98.8	15.2	8	4 - 12	NO
#200 – 0.075mm	29.9	4.6	4	2 - 6	YES

Calculations for Cores

AASHTO T 166 – Bulk Specific Gravity

$$G_{mb} = A / (B - C)$$

Where:

A = mass of dry sample
B = mass of SSD sample
C = mass of sample under water

Page 9-7

Calculate the Sublot & Lot Average to the nearest tenth.

MSG = 2.581

	A	C	B	B - C			
Core #	Mass in Air	Mass in Water	SSD in Air	Volume	Gmb	% Density	Sublot Avg.
1	884.7	532.6	892.8	360.2	2.456	95.2	95.4
2	738.8	446.5	745.9	299.4	2.468	95.6	

Gmb = A / (B-C)

Core #1: Gmb = 884.7 / (892.8 – 532.6)

= 884.7 / 360.2 = 2.456

% Density = Gmb ÷ MSG x 100

% Density = 2.456 / 2.581 x 100 = 95.2

Calculate the Sublot & Lot Average to the nearest tenth.

MSG = 2.581

	A	C	B				
Core #	Mass in Air	Mass in Water	SSD in Air	Volume	BSG	% Density	Sublot Avg.
1	884.7	532.6	892.8	360.2	2.456	95.2	95.4
2	738.8	446.5	745.9	299.4	2.468	95.6	
3	676.9	397.5	684.7	287.2	2.357	91.3	92.9
4	900.6	541.8	910.9	369.1	2.440	94.5	
5	872.8	505.3	876.7	371.4	2.350	91.0	91.4
6	761.8	448.6	770.4	321.8	2.367	91.7	
						Lot Avg.	93.2

Gmb = A / (B-C)

94

Questions - ?

95