E

Study Questions & Answers

This appendix contains study questions and problems from Chapters 3-10, along with answers and details on how problems were solved. (There are no study questions for Chapters 1 and 2.)

Use this appendix to check yourself and your learning. For multiple choice and true/false answers, the answers appear on the right, enabling you to cover the answer and reveal it after you have made your selection.

Chapter Three: Components of Asphalt Concrete

1.	A method of classification used to determine the performance properties of binder is:	D. Performance grading
2.	Binder blended with a kerosene-type material is known as:	C. MC asphalt
3.	A method of determining flow properties of binder is:	B. Viscosity
4.	Binder which has been liquefied with heat, petroleum solvents, or emulsified with water, is known as:	B. Liquid asphalt
5.	Binder blended with a naphtha or gasoline-type material is called:	D. RC asphalt
6.	An example of an artificial aggregate is blast furnace slag.	A. True
7.	Aggregates should be handled and stockpiled in such a manner as to minimize:	B. Segregation
8.	Hot-mix asphalt concrete can be considered to be made up of two ingredients:	B. Binder and aggregates
9.	A suspension of binder in water containing an emulsifying agent, such as soap, is called:	D. Emulsified asphalt
10.	Asphalt binders become harder (more viscous) as their temperature decreases and softer (less viscous) as their temperature increases	A. True
11.	How should the site for stockpiles be prepared?	The stockpile site should be on ground that is denuded of vegetation, hard, well drained or otherwise prepared to protect the aggregate from contamination.

12. How should stockpiles be handled?

Aggregates shall be handled, hauled and stored in a manner that will minimize segregation and avoid contamination.

13. How much material should be on hand before starting daily operations?

Enough to ensure continued processing for the working day.

Chapter Four: Asphalt Concrete Mixtures

1.	The frictional resistance of the surface of the pavement to insure safe driving and stopping of the vehicle is called:	D. Skid-resistance
2.	The ability of the asphalt pavement to withstand repeated flexing or slight bending caused by the passage of wheel loads is called:	B. Fatigue resistance
3.	The resistance of pavement to the effects of traffic, water, air, and temperature changes is known as:	A. Durability
4.	The ability of a pavement to adjust itself to settlement of the base without cracking is known as:	D. Flexibility
5.	The ease with which the material can be placed to the desired uniformity and compacted to the required density is known as:	C. Workability
6.	Type SM-12.5A asphalt concrete is a:	B. Surface course mix
7.	Four physical properties that are required of asphalt concrete mixtures are:	D. Stability, flexibility, durability, and resistance to skidding
8.	Type IM-19.0A asphalt concrete is:	C. Intermediate course mix
9.	The resistance an asphalt concrete pavement has to the passage of air and water into or through the pavement is known as:	C. Impermeability
10.	Type BM-25.0 asphalt concrete is a:	A. Base course mix
11.	The upper or top layer of an asphalt concrete pavement structure is the:	B. Surface course
12.	The subgrade ultimately carries all traffic loads.	A. True

13. The main structural strength element of a pavement is the: B. Base course

14. The layer of an asphalt concrete pavement that distributes traffic loads to the subgrade is the: C. Base course

15. Stability may be improved by using aggregates with rough surface texture. A. True

Chapter Five: Asphalt Concrete Plants

1. The overflow chutes on a batch plant are used to:	B. Prevent contamination by intermingling from adjacent bins
2. The asphalt material shall be delivered into the mixer in a thin, uniform sheet or multiple streams for the full width of the mixer.	A. True
3. Increasing the dryer time will remove more moisture than increasing the heat.	A. True
4. The asphalt content for batch weight calculations is obtained from the:	B. Job mix formula
5. During the drying operation, wet aggregate will reduce the dryer's capacity.	A. True
6. In the drum mix plant, moisture content of aggregate must be determined before drying.	A. True
7. The maximum amount of moisture allowed in the completed mixture is:	B. 1%
8. What conditions affect screening efficiency?	(1) Condition and cleanliness of screens (2) Excessive material being fed to screens (3) Excessive wearing causing enlarged openings (4) Screen not properly installed
9. What are some of the methods of controlling carry-over?	(1) Cleaning the screens (2) Regulating the quantity of material coming from the cold feed (3) Daily visual inspection of the screens for defects

Question	Answer
10. What is meant by proportioning of aggregates and asphalt?	Blending of the correct amount of each size aggregate and the correct amount of asphalt to produce the required mix.
11. What conditions will best insure a uniform flow of the proper aggregate sizes from the cold feed?	(1) Correct sizes of aggregates in the stockpile (2) Segregation should be prevented (3) Intermixing of stockpiles should be prevented (4) Feeder gates should be accurately calibrated, set and secured (5) Gates should be kept clear of obstruction (6) Excessive arching in the fine aggregates should not be allowed
12. Why is proper cold feeding essential?	(1) A sudden rush of cold sand may cause a considerable change of temperature in the aggregate leaving the dryer (2) A sudden increase in the cold feed can overflow the screens (3) Erratic feeding may cause some bins to overfill while starving others
13. When hydrated lime is used in asphalt concrete as an anti-stripping additive, it shall be added at what rate?	Not less than one percent by weight of the total dry aggregate
14. What problems arise from overheating?	The asphalt can be damaged
15. What problems arise from underheating aggregate?	(1) Aggregate is difficult to coat (2) Mix is difficult to place (3) Aggregate may not be dry enough
16. What could cause leakage of aggregate into the weigh hopper after the desired amount has been withdrawn?	Worn gates on the bottom of the bins.
17. How often and by whom should hopper and truck scales be serviced and tested?	At least every six months by a scale service representative.

18. How often and by whom shall scales used in the weighing of materials paid for on a tonnage basis be approved and sealed?	Every six months and upon being moved The Bureau of Weights and Measures approves and seals
19. When using a metering device instead of a weigh bucket for proportioning asphalt to the mixer, what is one important thing that should be remembered?	The metering device shall be calibrated for accuracy.
20. What is the maximum dry mixing time for aggregates released into the pugmill?	Fifteen (15) seconds
21. What is the minimum wet mixing time allowed?	Twenty (20) seconds
22. Who determines the mixing time? Who approves the mixing time?	The Producer's technician determines the mixing time. Approval is by the District Materials Engineer.
23. Asphalt storage at the plant should be equal to at least:	B. One day's output

Problem No. 1 Answers: Establishing the Wet Mixing Time

Given: The plant is operating on a 22-second wet mixing cycle. Two previous determinations yielded results of 94.3% and 95.1% completely coated particles. The third determination has shown that of the 230 particles there are 6 that are not completely coated.

Find:

1. The Ross Count for the third determination.

$$\text{Ross Count} = \frac{\text{Number of Completely Coated Particles}}{\text{Total Number of Particles}} \times 100$$

Step 1) 230 – 6 = 224

Step 2) $\frac{224}{230} \times 100$

Step 3) 0.9739 X 100 = 97.4%

2. Does this meet the VDOT requirements for the wet mixing time? **Yes**

Step 1) 94.3 + 95.1 + 97.4 = 286.8

Step 2) $\frac{286.8}{3}$ X 100

3. What steps are taken if after conducting a Ross Count, the results do not meet VDOT requirements?

A. Increase the mixing time 5 seconds and repeat test.

B. Does not meet requirements if an average of 3 samples is less than 95% or one sample is less than 92%.

Problem No. 2 Answers: Establishing the Wet Mixing Time

Given: The plant is operating on a 21-second wet mixing cycle. Two previous determinations yielded results of 95.3% and 92.5% completely coated particles. The third determination has shown that of the 216 particles there are 14 that are not completely coated.

Find:

1. The Ross Count for the third determination. 93.5%

$$\text{Ross Count} = \frac{\text{Number of Completely Coated Particles}}{\text{Total Number of Particles}} \text{ X 100}$$

Step 1) 216 – 14 = 202

Step 2) $\frac{202}{216}$ X 100

Step 3) 0.935 x 100 = 93.5%

2. Does this meet the VDOT requirements for the wet mixing time? **No**

Step 1) 95.3 + 92.5 + 93.5 = 281.3

Step 2) $\frac{281.3}{3}$ X 93.8%

3. What steps are taken if after conducting a Ross Count, the results do not meet VDOT requirements?

   A. Increase the mixing time 5 seconds and repeat test.

   B. Does not meet requirements if an average of 3 samples is less than 95% or one sample is less than 92%.

Problem No. 3 Answers: Determining Aggregate Moisture

Determine the percent moisture in an aggregate sample that had a wet weight of 1335 grams, and after drying, a dry weight of 1290 grams. (Answer to nearest tenth of a percent.)

$$\% \text{ Moisture} = \frac{\text{Wet Weight} - \text{Dry Weight}}{\text{Dry Weight}} \text{ X } 100$$

Step 1) $\frac{1335 - 1290}{1290} \text{ X } 100$

Step 2) $\frac{45}{1290} \text{ X } 100$

Step 3) 0.0349 x 100 = **3.5%**

Problem No. 4 Answers: Determining Aggregate Moisture

Determine the percent moisture in an aggregate sample that had a wet weight of 1275 grams, and after drying, a dry weight of 1235 grams. (Answer to nearest tenth of a percent.)

$$\% \text{ Moisture} = \frac{\text{Wet Weight} - \text{Dry Weight}}{\text{Dry Weight}} \text{ X } 100$$

Step 1) $\frac{1275 - 1235}{1235} \text{ X } 100$

Step 2) $\frac{40}{1235} \text{ X } 100$

Step 3) 0.0324 x 100 = **3.2%**

Problem No. 5 Answers: Determining Moisture of an Asphalt Mixture

Given the Following information, determine the percent moisture in the BM-25.0 asphalt concrete sample below.

Does this meet the VDOT Specifications? **Yes**

Weight of Moist Sample = 2254
Weight of Dry Sample = 2232

$$\% \text{ Moisture} = \frac{\text{Wet Weight} - \text{Dry Weight}}{\text{Dry Weight}} \times 100$$

Step 1) $\frac{2254 - 2232}{2232} \times 100$

Step 2) $\frac{22}{2232} \times 100$

Step 3) 0.0099 x 100 = 0.99 or **1.0%**

The moisture content of an asphalt mixture should not exceed 1%

Problem No. 6 Answers: Determining Moisture of an Asphalt Mixture

Given the following information, determine the percent moisture in the BM-25.0 asphalt concrete sample below.

Does this meet the VDOT Specifications? **No**

Weight of Moist Sample = 2376
Weight of Dry Sample = 2342

$$\% \text{ Moisture} = \frac{\text{Wet Weight} - \text{Dry Weight}}{\text{Dry Weight}} \times 100$$

Step 1) $\frac{2376 - 2342}{2342} \times 100$

Step 2) $\frac{34}{2242} \times 100$

Step 3) 0.0145 x 100 = 1.45 or **1.5%**

The moisture content of an asphalt mixture should not exceed 1%

Chapter Six: Sampling and Analysis of Aggregates

1.	A process in which an aggregate is separated into its various sizes by passing it through screens of various size openings for the purpose of determining the distribution and particle size is:	B. Sieve analysis
2.	Coarse aggregate used in Asphalt Concrete is defined as all the material retained on or above the:	A. No.4 (4.75 mm) sieve
3.	A relatively small portion of material having the same physical properties as the group or lot from which it is taken is called a:	B. Representative sample
4.	Fine aggregate used in Asphalt Concrete is defined as all the material passing the:	A. No. 4 (4.75 mm) sieve
5.	What is the most important thing in sampling of materials?	Obtaining the average gradation of a material.
6.	What determines the size sample required to run a sieve analysis?	The size of the sample will vary according to the aggregate size; the larger the aggregate size, the larger the sample would have to be to remain a representative sample.
7.	What are two methods of reducing an aggregate sample to size for testing?	(1) Sample splitter (2) Quartering
8.	How would you prepare a sample for sieve analysis?	1) Reduce sample to proper size by splitting or quartering 2) Dry thoroughly 3) Weigh and record total dry weight of sample before washing
9.	Washed sieve analysis is a method used in Virginia for asphalt mixes for determining proportions of various particle sizes in a mineral aggregate.	A. True

10. The purpose of the washed sieve analysis is to separate the amount of material finer than what size sieve?	No. 200 (75µm) sieve
11. Which dry weight is used to calculate the percent retained?	A. Total dry weight of sample before washing
12. As a check against sample loss when running a sieve analysis, the combined grams on each individual sieve, in the weight retained column, should equal the:	B. Dry weight of sample after washing
13. How are the different sizes of aggregate in a sample separated?	By using the correct sieves selected for compliance with the specification.
14. When conducting a sieve analysis, after the total sample has been shaken, the weight of material retained on each sieve size is recorded.	A. True

Problem No. 1 Answers: Determining Gradation

Complete the following analysis.

Total dry weight of aggregate before washing 1043.7 grams
Dry weight of aggregate after washing 1030.7 grams

Sieve	Wt. Retained on each sieve	% Retained	% Passing
3/4 in	0	0	100.0
1/2 in	0	0	100.0
3/8 in	0	0	100.0
No. 4	1.5	0.1	99.9
No. 8	98.9	9.5	90.4
No. 30	470.7	45.1	45.3
No. 50	353.2	33.8	11.5
No. 200	103.3	9.9	1.6
Pan	3.1		

$$\text{Percent Retained} = \frac{\text{Wt. on the sieve}}{\text{Total dry wt. of sample}} \times 100$$

No 4) $\frac{1.5}{1043.7} \times 100 =$ **0.1**

No 8) $\frac{98.9}{1043.7} \times 100 =$ **9.5**

No 30) $\frac{470.7}{1043.7} \times 100 =$ **45.1**

No 50) $\frac{353.2}{1043.7} \times 100 =$ **33.8**

No 200 $\frac{103.3}{1043.7} \times 100 =$ **9.9**

Total percent passing each sieve

100	99.9	90.4	45.3	11.5
- 0.1	- 9.5	- 45.1	- 33.8	- 9.9
99.9	90.4	45.3	11.5	1.6

Problem No. 2 Answers: Determining Gradation

Complete the following analysis.

Total dry weight of aggregate before washing 1474.1 grams
Dry weight of aggregate after washing 1328.3 grams

Sieve	Wt. Retained on each sieve	% Retained	% Passing
3/4 in	0	0	100.0
1/2 in	0	0	100.0
3/8 in	0	0	100.0
No. 4	16.4	1.1	98.9
No. 8	379.5	25.7	73.2
No. 30	532.4	36.1	37.1
No. 50	172.1	11.7	25.4
No. 200	205.1	13.9	11.5
Pan	22.7		

$$\text{Percent Retained} = \frac{\text{Wt. on the sieve}}{\text{Total dry wt. of sample}} \times 100$$

No 4) $\frac{16.4}{1474.1} \times 100 = \mathbf{1.1}$

No 8) $\frac{379.5}{1474.1} \times 100 = \mathbf{25.7}$

No 30) $\frac{532.4}{1474.1} \times 100 = \mathbf{36.1}$

No 50) $\frac{172.1}{1474.1} \times 100 = \mathbf{11.7}$

No 200 $\frac{205.1}{1474.1} \times 100 = \mathbf{13.9}$

Total percent passing each sieve

100	98.9	73.2	37.1	25.4
- 1.1	- 25.7	- 36.1	- 11.7	- 13.9
98.9	73.2	37.1	25.4	11.5

Problem No. 3 Answers: Determining Gradation

Total dry weight of aggregate before washing 1917.8 grams
Dry weight of aggregate after washing 1815.0 grams

Sieve	Wt. Retained on each sieve	% Retained	% Passing
2 in	0	0	100.0
1 ½ in	0	0	100.0
1 in	154.8	8.1	91.9
3/4 in	191.9	10.0	81.9
1/2 in	243.1	12.7	69.2
3/8 in	148.1	7.7	61.5
No. 4	381.3	19.9	41.6
No. 8	353.9	18.5	23.1
No. 30	211.1	11.0	12.1
No. 50	85.7	4.5	7.6
No. 100	29.3	1.5	6.1
No. 200	15.8	0.8	5.3

$$\text{Percent Retained} = \frac{\text{Wt. on the sieve}}{\text{Total dry wt. of sample}} \times 100$$

1 inch) $\frac{154.8}{1917.8} \times 100 = \mathbf{8.1}$

3/4 inch) $\frac{191.9}{1917.8} \times 100 = \mathbf{10.0}$

1/2 inch) $\frac{243.1}{1917.8} \times 100 = \mathbf{12.7}$

3/8 inch) $\frac{148.1}{1917.8} \times 100 = \mathbf{7.7}$

No. 4) $\frac{381.3}{1917.8} \times 100 = \mathbf{19.9}$

No. 8) $\frac{353.9}{1917.8} \times 100 = \mathbf{18.5}$

No. 30) $\frac{211.1}{1917.8} \times 100 = \mathbf{11.0}$

No. 50) $\frac{85.7}{1917.8} \times 100 = \mathbf{4.5}$

No. 100) $\frac{29.3}{1917.8} \times 100 = \mathbf{1.5}$

No. 200) $\frac{15.8}{1917.8} \times 100 = \mathbf{0.8}$

Total percent passing each sieve

100	91.9	81.9	69.2	61.5	23.1	12.1	7.6	6.1
- 8.1	- 10.0	- 12.7	- 7.7	- 18.5	- 11.0	- 4.5	- 1.5	- 0.8
69.2	**81.9**	**69.2**	**61.5**	**23.1**	**12.1**	**7.6**	**6.1**	**5.3**

Problem No. 4 Answers: Determining Gradation

Mix Type: **SM-12.5E**

Total dry weight of aggregate before washing 1075.0 grams
Dry weight of aggregate after washing 1017.8 grams

Sieve	Wt. Retained on each sieve	% Retained	% Passing
2 in	0	0	100.0
1 ½ in	0	0	100.0
1 in	0	0	100
3/4 in	0	0	100
1/2 in	13.3	1.2	98.8
3/8 in	102.3	9.5	89.3
No. 4	305.8	28.4	60.9
No. 8	126.0	11.7	49.2
No. 30	299.7	27.9	21.3
No. 50	103.4	9.6	11.7
No. 100	43.3	4.0	7.7
No. 200	24.0	2.2	5.5

$$\text{Percent Retained} = \frac{\text{Wt. on the sieve}}{\text{Total dry wt. of sample}} \times 100$$

1/2 inch) $\frac{13.3}{1075.0} \times 100 = \mathbf{1.2}$

3/8 inch) $\frac{102.3}{1075.0} \times 100 = \mathbf{9.5}$

No. 4) $\frac{305.8}{1075.0} \times 100 = \mathbf{28.4}$

No. 8) $\frac{126.0}{1075.0} \times 100 = \mathbf{11.7}$

No. 30) $\frac{299.7}{1075.0} \times 100 = \mathbf{27.9}$

No. 50) $\frac{103.4}{1075.0} \times 100 = \mathbf{9.6}$

No. 100) $\frac{43.3}{1075.0} \times 100 = \mathbf{4.0}$

No. 200) $\frac{24.0}{1075.0} \times 100 = \mathbf{2.2}$

Total percent passing each sieve

100	98.8	89.3	60.9	49.2	21.3	11.7	7.7
- 1.2	- 9.5	- 28.4	- 11.7	- 27.9	- 9.6	- 4.0	- 2.2
98.8	**89.3**	**60.9**	**49.2**	**21.3**	**11.7**	**7.7**	**5.5**

Problem No. 5 Answers: Determining Gradation

Determine the gradation of the extracted aggregate (answer to the nearest tenth of a percent) for the following asphalt concrete mixture.

Mix Type: **SM – 12.5D**

Total dry weight of aggregate before washing 1179.9 grams
Dry weight of aggregate after washing 1143.2 grams

Sieve	Wt. Retained on each sieve	% Retained	% Passing
2 in			
1 ½ in			
1 in			
3/4 in	0	0	100
1/2 in	0	0	100
3/8 in	73.2	6.2	93.8
No. 4	362.0	30.7	63.1
No. 8	202.9	17.2	45.9
No. 30	259.3	22.0	23.9
No. 50	161.4	13.7	10.2
No. 100	61.7	5.2	5.0
No. 200	22.7	1.9	3.1

$$\text{Percent Retained} = \frac{\text{Wt. on the sieve}}{\text{Total dry wt. of sample}} \times 100$$

Chapter Seven: Blending Aggregates

	Question	Answer
1.	Where are the design range limits found for the different types of asphalt concrete mixtures?	VDOT *Road and Bridge Specifications Book*, Section 211.03 - Job Mix Formula Table II-13
2.	If the job mix on the 1/2 inch (12.5 mm) sieve is 81% passing, what is the acceptance range for the 8 tests?	Section 211.08 Table II-15 (± 2.8) **78.2 – 83.8**
3.	To whom should the job-mix be submitted?	Section 211.03 The Engineer (the District Materials Engineer)
4.	The range from which the job mix is chosen is called:	B. Design range
5.	The "Trial and Error" method is commonly used to determine the relative proportions of different aggregates needed to produce a final gradation that meets specifications.	A. True
6.	The target values for the combined gradation are provided by:	C. The Asphalt Mix Design Technician

Problem No. 1 Answers: Cold Feed Blending Worksheet

Determine the Job Mix Formula (Total Blend)

Type Mix: **SM-12.5A**

Mat'l	**Screenings**		**Stone**				
% Used	**45**		**55**				
Sieve (in)	**% Pass**	**% Blend**	**% Pass**	**% Blend**	**Total Blend**	**Target Value**	**Design Range**
1 1/2 in							
1 in							
3/4 in	100	45	100	55	100	100	100
1/2 in	100	45	98	53.9	99	98	95 - 100
3/8 in	100	45	77	42.4	87	88	90 max
No. 4							
No. 8	100	45	9	5	50	49	34 - 50
No. 30							
No. 50							
No. 200	12	5.4	0	0	5.4	5.5	2 - 10

This is just one example of blending choices.

Problem No. 2 Answers: Cold Feed Blending Worksheet

Determine the Job-Mix Formula (Total Blend)

Type Mix: **IM-19.0D**

Mat'l % Used	No. 10		1/2" Cr/ Run		No. 68				
	35		30		35				
Sieve (in)	**% Pass**	**% Blend**	**% Pass**	**% Blend**	**% Pass**	**% Blend**	**Total Blend**	**Target Value**	**Design Range**
1 1/2 in									
1 in	100	35	100	30	100	35	100	100	100
3/4 in	100	35	99	29.7	96	33.6	98	98	90 – 100
1/2 in	100	35	89	26.7	47	16.5	78	79	90 max
3/8 in									
No. 4									
No. 8	99	34.7	41	12.3	9	3.2	50	49	28 - 49
No. 30									
No. 50									
No. 200	10	3.5	2.5	0.8	0	0	4.3	4.5	2 - 8

This is just one example of blending choices.

Problem No. 3 Answers: Cold Feed Blending Worksheet

Determine the Job-Mix Formula (Total Blend)

Type Mix: **SM-12.5D**

Mat'l % Used	No. 78		No. 10		Sand				
	45		30		25				
Sieve (in)	**% Pass**	**% Blend**	**% Pass**	**% Blend**	**% Pass**	**% Blend**	**Total Blend**	**Target Value**	**Design Range**
1 1/2 in									
1 in									
3/4 in	100	45	100	30	100	25	100	100	100
1/2 in	96	43.2	99	29.7	100	25	98	98	95 - 100
3/8 in	75	33.8	95	28.5	100	25	87	88	90 max
No. 4									
No. 8	11	5	65	19.5	100	25	50	49	34 - 50
No. 30									
No. 50									
No. 200	0	0	14	4.2	1.4	0.4	4.6	5.5	2 - 10

This is just one example of blending choices

Problem No. 4 Answers: Hot Bins Blending Worksheet

Batch Plant set up:

A. Determination of hot bin proportions.
   1. Determine the percentage to be pulled from each bin to meet the job mix formula.
   2. Show blend determined under column listed "total blend."
   3. Show acceptance range in column listed "acceptance range."

Determine the Job-Mix Formula (Total Blend)

Type Mix: **BM-25.0**

Bin No.	Bin 1		Bin 2		Bin 3		Bin 4				
% Used	35		20		20		25				
Sieve (in)	% Pass	% Blend	% Pass	% Blend	% Pass	% Blend	% Pass	% Blend	Total Blend	Job-Mix Formula	Accept Range
1 1/2 in	100	**35**	100	**20**	100	**20**	100	**25**	**100**	100	**100**
1 in	100	**35**	100	**20**	99	**19.8**	91	**22.8**	**98**	98	**95.2 - 100**
3/4 in	100	**35**	100	**20**	88	**17.6**	8	**2**	**75**	76	**73.2– 78.8**
1/2 in											
3/8 in											
No. 4											
No. 8	86	**30.1**	13	**2.6**	3	**0.6**	0	**0**	**33**	32	**29.2– 34.8**
No. 30											
No. 50											
No. 200	10	**3.5**	0	**0**	0	**0**	0	**0**	**3.5**	4	**3.3 – 4.7**

B. Using the percentage determined to be pulled from each bin above and an asphalt content of 4.5%, calculate the weight of asphalt, weight of aggregates from each bin, and accumulative weights per bin to be pulled in an 8000 pound batch.

Bins	Percent	Weight of Aggregates per Bin	Accumulative Weights per Bin
Bin 1	35	2674	2674
Bin 2	20	1528	4202
Bin 3	20	1528	5730
Bin 4	25	1910	7640
	Weight of Asphalt	**360**	

Problem 5 Answers: Hot Bin Blending Worksheet

Batch Plant set up:

A. Determination of hot bin proportions.
   1. Determine the percentage to be pulled from each bin to meet the job mix formula.
   2. Show blend determined under column listed "total blend."
   3. Show acceptance range in column listed "acceptance range."

Determine the Job-Mix Formula (Total Blend)

Type Mix: **IM-19.0 A**

Bin No.	**Bin 1**		**Bin 2**		**Bin 3**		**Bin 4**				
% Used	**25**		**20**		**30**		**25**				
Sieve (in)	**% Pass**	**% Blend**	**% Pass**	**% Blend**	**% Pass**	**% Blend**	**% Pass**	**% Blend**	**Total Blend**	**Job-Mix Formula**	**Accept Range**
1 1/2 in											
1 in	100	**25**	100	**20**	100	**30**	100	**25**	**100**	100	**100**
3/4 in	100	**25**	100	**20**	93	**27.9**	91	**22.8**	**96**	97	**94.2 -99.8**
1/2 in	100	**25**	92	**18.4**	71	**21.3**	30	**7.5**	**72**	72	**69.2– 74.8**
3/8 in											
No. 4											
No. 8	87	**21.8**	37	**7.4**	18	**5.4**	5	**1.3**	**36**	37	**34.2– 39.8**
No. 30											
No. 50											
No. 200	24	**6**	1.5	**0.3**	0	**0**	0	**8.5**	**6.5**	6.5	**5.8 – 7.2**

B. Using the percentage determined to be pulled from each bin above and an asphalt content of 4.7%, calculate the weight of asphalt, weight of aggregates from each bin, and accumulative weights per bin to be pulled in a 5500 pound batch.

Bins	**Percent**	**Weight of Aggregates per Bin**	**Accumulative Weights per Bin**
Bin 1	25	1310	1310
Bin 2	20	1048	2358
Bin 3	30	1572	3930
Bin 4	25	1310	5240
	Weight of Asphalt	259	

Chapter Eight: Duties of the Technician

1.	Who is responsible for the submission of the job mix formula?	B. Asphalt Contractor/Technician
2.	Who approves the job-mix formula?	C. District Materials Engineer
3.	Whose responsibility is it to assure that all materials are properly handled and stored?	A. Asphalt Mix Design Contractor/Technician
4.	Asphalt cement used for state work must be certified or tested.	A. True
5.	Whose responsibility is it to sample, make proportioning determinations and to make all adjustments necessary to insure proper operational control?	B. Contractor's Asphalt Mix Design Technician
6.	A chart that shall be set up to alert the Producer when to investigate his process is known as the:	B. Control chart
7.	Samples taken from equal portions of a lot at locations which have been selected solely by chance are known as:	C. Stratified random samples
8.	A method to re-evaluate asphalt concrete when there is doubt that the original test results are valid is known as the:	B. Referee system
9.	Where should monitor samples be taken?	B. At the plant
10.	Monitor samples are taken by the Producer's Certified Asphalt Concrete Plant Technician in the presence of the District Monitor.	A. True
11.	What is the maximum time required after production starts before taking the first sample?	No time limit
12.	What procedure should be used when two samples are randomly selected to be taken from one truckload of material?	Discard the second number and draw again.

13. How should the sample be taken from the truck?	Take the sample from the approximate center of the truckload. Strike off the top 6 inches of material and take the sample horizontally, 6-12 inches below the surface of the load.
14. What is the normal size of a lot?	4000 tons
15. What is the difference between random sampling and representative sampling?	Random samples are selected solely by chance. A representative sample is selected by trying to sample the "average" of the material.
16. In stratified random sampling, what would be the number of samples required per 4000 ton lot?	8 samples per 4000 ton lot

Chapter Nine: Testing of Asphalt Concrete

1.	The Ignition Method test utilizes a sample of Asphalt Concrete taken from the truck.	A. True
2.	The Ignition Oven is the method used to determine the asphalt content in asphalt mixtures.	A. True
3.	The Virginia test method for determining the Percent Binder or Asphalt Content in asphalt mixtures is the centrifuge method.	B. False
4.	The actual test sample of an asphalt mixture used in the Ignition Oven shall be a minimum of 1500 grams for an SM-12.5A mix.	A. True
5.	What is the purpose of the Ignition Method?	To determine the asphalt content for a mixture and recover aggregate for the sieve analysis
6.	Specifications allow what percent voids in the total mix for an SM-12.5A?	2.0 – 5.0 percent
7.	VFA are voids in a filler aggregate in asphalt mixtures.	B. False
8.	VMA are voids in a mineral aggregate.	A. True
9.	Asphalt test procedures can be found in the appropriate AASHTO procedure or Virginia Test Method (VTM).	A. True
10.	__________________ is added to asphalt as an anti-stripping agent.	Hydrated lime
11.	The ________________ Test checks the effectiveness of an anti-stripping additive.	Boil

Problem No. 1 Answers: Volumetric Calculations

The results of laboratory testing of a SM-9.5A yielded the following results:

Asphalt Content = 5.05
Correction Factor = .017
Asphalt Binder Specific Gravity = 1.030
Percent minus 200 = 4.5

1. Complete the following tables:
Maximum Specific Gravity of Mix (G_{mm}):

$$G_{mm} = \frac{(C - A)}{(C - A) - (D - B)}$$

Variables		Grams
Mass Container in Air	A	741.2
Mass Container in Water	B	647.2
Mass Container and Sample in Air	C	2724.6
Mass Container and Sample in Water	D	1852.8
Maximum Specific Gravity (G_{mm}) =		**2.550**

$$\frac{2724.6 - 741.2}{(2724.6 - 741.2) - (1852.8 - 647.2)} = \frac{1983.4}{1983.4 - 1205.6} \quad \frac{1983.4}{777.8} \quad \mathbf{2.550}$$

Bulk Specific Gravity of Mix (G_{mb}):

Variables		Specimen 1	Specimen 2	Specimen3
Mass of Specimen in Air	**A**	4797.7	4790.8	4791.1
SSD mass of Specimen	**B**	4799.5	4792.6	4792.9
Mass of Specimen in Water	**C**	2830.7	2828.5	2828.0
Specimen Bulk Specific Gravity		**2.437**	**2.439**	**2.438**
Average G_{mb} =		**2.438**		

Specimen Bulk Specific Gravity $G_{mb} = \frac{A}{B - C}$

G_{mb} Specimen 1 $\frac{4797.7}{(4799.5 - 2830.7)} = \frac{4797.7}{1968.8} =$ **2.437**

G_{mb} Specimen 2 $\frac{4790.8}{(4792.6 - 2828.5)} = \frac{4790.8}{1964.1} =$ **2.439**

G_{mb} Specimen 3 $\frac{4791.1}{(4792.9 - 2828.0)} = \frac{4791.1}{1964.9} =$ **2.438**

$$\text{Avg. } G_{mb} = \frac{G_{mb} \text{ Specimen 1} + G_{mb} \text{ Specimen 2} + G_{mb} \text{ Specimen 3}}{3}$$

$$\text{Avg. } G_{mb} = \frac{2.437 + 2.439 + 2.438}{3} = \frac{7.314}{3} = \mathbf{2.438}$$

2A. Calculate the Effective Specific Gravity of the Aggregate (G_{se}) = **2.767**

[100% (total sample) - % asphalt content] = P_s 100 – 5.05 = 94.95

$$G_{se} = \frac{P_s}{\left(\frac{100}{G_{mm}}\right) - \left(\frac{P_b}{G_b}\right)} \qquad G_{se} = \frac{94.95}{\left(\frac{100}{2.550}\right) - \left(\frac{5.0}{1.030}\right)} = \frac{94.95}{39.22 - 4.90} = \frac{94.95}{34.32} = \mathbf{2.767}$$

2B. Calculate the Bulk Specific Gravity of the Aggregate (Gsb) = **2.75**

$G_{sb} = G_{se} - CF = 2.767 - 0.017 =$ **2.75**

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3. Calculate the VTM, VMA, VFA, and F/A ratio for this mix.

VTM

$$VTM = 100 \times \left[1 - \left(\frac{\text{Avg. } G_{mb}}{G_{mm}}\right)\right]$$

$$VTM = 100 \times \left[1 - \left(\frac{2.438}{2.550}\right)\right] \qquad VTM = 100 \times (1 - 0.956) \qquad VTM = 100 \times 0.044 = \mathbf{4.4}$$

VMA

$$VMA = 100 - \left(\frac{\text{Avg. } G_{mb} \times P_s}{G_{sb}}\right)$$

$$VMA = 100 - \left(\frac{2.438 \times 94.95}{2.75}\right)$$

$$VMA = 100 - \left(\frac{231.4881}{2.75}\right)$$

VMA = 100 – 84.18

VMA = **15.8**

VFA

$$VFA = \left[\left(\frac{VMA - VTM}{VMA}\right)\right] \times 100$$

$$VFA = \left[\left(\frac{15.8 - 4.4}{15.8}\right)\right] \times 100$$

$$VFA = \frac{11.4}{15.8} \times 100$$

VFA = 0.722 x 100 = **72**

F/A Ratio – First must calculate the Effective Asphalt Content (P_{be})

$$P_{be} = P_b - \left[(P_s \times G_b) \times \left(\frac{(G_{se} - G_{sb})}{(G_{se} \times G_{sb})}\right)\right]$$

$$P_{be} = 5.05 - \left[(94.95 \times 1.03) \times \left(\frac{(2.767 - 2.750)}{(2.767 \times 2.750)}\right)\right]$$

$$P_{be} = 5.05 - \left[97.80 \times \left(\frac{0.017}{7.609}\right)\right]$$

P_{be} = 5.05 - [97.80 X 0.002]

P_{be} = 5.05 - 0.2

Pbe = **4.85**

$$\text{F/A Ratio} = \frac{\text{\% passing 200 aieve}}{P_{be}}$$

$$\text{F/A Ratio} = \frac{4.5}{4.85}$$

F/A Ratio = **0.9**

4. Do all the volumetric properties meet the mix design criteria for this mix during production?

Design Range Criteria Specification Criteria Calculated Results:

Design Range Criteria	Specification Criteria	Calculated Results	Meet Spec.?
VTM	2.0 – 5.0	4.4	Yes
VMA	Min. 15	15.8	Yes
VFA	68 – 84	72	Yes
F/A	0.6 – 1.2	0.9	Yes

Problem No. 2 Answers: Volumetric Calculations

The results of laboratory testing of a SM-12.5D yielded the following results:

Asphalt Content = 5.01

Correction Factor = .018

Asphalt Binder Specific Gravity = 1.030

Percent minus 200 = 6.2

1. Complete the following tables:

Maximum Specific Gravity of Mix (G_{mm}):

$$G_{mm} = \frac{C - A}{(C - A) - (D - B)}$$

Variables		Grams
Mass Container in Air	**A**	745.9
Mass Container in Water	**B**	651.2
Mass Container and Sample in Air	**C**	2779.4
Mass Container and Sample in Water	**D**	1875
Maximum Specific Gravity (G_{mm}) =		**2.511**

$$\frac{2779.4 - 745.9}{(2779.4 - 745.9) - (1875.0 - 651.2)} = \frac{2033.5}{2033.5 - 1223.8} \quad \frac{2033.5}{809.7} \quad \mathbf{2.511}$$

Bulk Specific Gravity of Mix (G_{mb}):

Variables		Specimen 1	Specimen 2	Specimen3
Mass of Specimen in Air	**A**	4793.7	4792.9	4789.0
SSD Mass of Specimen	**B**	4799.2	4796.1	4791.9
Mass of Specimen in Water	**C**	2845.5	2846.5	2844.2
Specimen Bulk Specific Gravity		**2.454**	**2.458**	**2.459**
Average G_{mb} =		**2.457**		

Specimen Bulk Specific Gravity

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

$$G_{mb} \text{ Specimen 1} \quad \frac{4793.7}{(4799.2 - 2845.5)} = \frac{4793.7}{1953.7} = \mathbf{2.454}$$

$$G_{mb} \text{ Specimen 2} \quad \frac{4792.9}{(4796.1 - 2846.5)} = \frac{4792.9}{1964.1} = \mathbf{2.458}$$

$$G_{mb} \text{ Specimen 3} \quad \frac{4789.0}{(4791.9 - 2844.2)} = \frac{4789.0}{1947.7} = \mathbf{2.459}$$

$$\text{Avg. } G_{mb} \quad \frac{G_{mb} \text{ Specimen 1} + G_{mb} \text{ Specimen 2} + G_{mb} \text{ Specimen 3}}{3}$$

$$\text{Avg. } G_{mb} \quad \frac{2.454 + 2.458 + 2.459}{3} = \frac{7.371}{3} = \mathbf{2.457}$$

2A. Calculate the Effective Specific Gravity of the Aggregate (G_{se}) = **2.717**

[100% (total sample) - % asphalt content] = P_s

100 – 5.01 = **94.99**

$$G_{se} = \frac{P_s}{\left(\frac{100}{G_{mm}}\right) - \left(\frac{P_b}{G_b}\right)} \qquad G_{se} = \frac{94.99}{\left(\frac{100}{2.511}\right) - \left(\frac{5.01}{1.030}\right)} = \frac{94.99}{39.82 - 4.86} = \frac{94.99}{34.96} = \mathbf{2.717}$$

2B. Calculate the Bulk Specific Gravity of the Aggregate (G_{sb}) = **2.699**

$G_{sb} = G_{se} - CF$ 2.717 – 0.018 = **2.699**

3. Calculate the VTM, VMA, VFA, and F/A ratio for this mix.

VTM

$$VTM = 100 \times \left[1 - \left(\frac{Avg.\ G_{mb}}{G_{mm}}\right)\right]$$

$$VTM = 100 \times \left[1 - \left(\frac{2.457}{2.511}\right)\right]$$ VTM = 100 x (1 – 0.978) VTM = 100 x 0.022 = **2.2**

VMA

$$VMA = 100 - \left(\frac{Avg.\ G_{mb} \times P_s}{G_{sb}}\right)$$

$$VMA = 100 - \left(\frac{2.457 \times 94.99}{2.699}\right)$$ $$VMA = 100 - \left(\frac{233.390}{2.699}\right)$$ VMA = 100 – 86.47 = **13.5**

VFA

$$VFA = \left[\frac{(VMA - VTM)}{VMA}\right] X\ 100$$ $$VFA = \left[\frac{(13.5 - 2.2)}{13.5}\right] X\ 100$$ $$VFA = \frac{11.3}{13.5} \times 100$$ VFA = 0.837 x 100

VFA = **84**

F/A Ratio - First must calculate the effective Asphalt Content (P_{be})

$$P_{be} = P_b - \left[(P_s \times G_b) \times \left(\frac{(G_{se} - G_{sb})}{(G_{se} \times G_{sb})} \right) \right]$$

$$P_{be} = 5.01 - \left[(94.99 \times 1.03) \times \left(\frac{(2.717 - 2.699)}{(2.717 \times 2.699)} \right) \right]$$

$$P_{be} = 5.01 - \left[97.84 \times \left(\frac{0.018}{7.333} \right) \right]$$

$$P_{be} = 5.01 - [97.84 \times 0.002]$$

$$P_{be} = 5.01 - 0.2$$

P_{be} = **4.81**

$$F/A = \frac{\text{\% passing \#200 sieve}}{P_{se}}$$

$$F/A = \frac{6.2}{4.81}$$

F/A = **1.3**

4. Do all the volumetric properties meet the mix design criteria for this mix during production?

Design Range Criteria	Specification Criteria	Calculated Results	Meet Spec.?
VTM	2.0 – 5.0	2.2	Yes
VMA	Min. 14	13.5	No
VFA	65 – 83	84	No
F/A	0.6 – 1.2	1.3	No

Problem No. 3 Answers: Volumetric Calculations

The results of laboratory testing of an IM-19.0A yielded the following results:

Asphalt Content = 5.40

Correction Factor = .023

Asphalt Binder Specific Gravity = 1.030

Percent minus 200 = 6.0

1. Complete the following tables:

Maximum Specific Gravity of Mix (G_{mm}):

$$G_{mm} = \frac{(C - A)}{(C - A) - (D - B)}$$

Variables		Grams
Mass Container in Air	**A**	746.9
Mass Container in Water	**B**	651.2
Mass Container and Sample in Air	**C**	2923.9
Mass Container and Sample in Water	**D**	1956.7
Maximum Specific Gravity (G_{mm}) =		**2.498**

$$\frac{2923.9 - 746.8}{(2923.9 - 746.8) - (1875.0 - 651.2)} = \frac{2177.1}{2177.1 - 1305.5} \quad \frac{1983.4}{871.6} \quad \mathbf{2.498}$$

Bulk Specific Gravity of Mix (G_{mb}):

Variables		Specimen 1	Specimen 2	Specimen3
Mass of Specimen in Air	**A**	4790.5	4791.4	4789.1
SSD Mass of Specimen	**B**	4795.0	4794.9	4792.4
Mass of Specimen in Water	**C**	2810.0	2813.3	2809.2
Specimen Bulk Specific Gravity		**2.413**	**2.418**	**2.415**
Average G_{mb} =		**2.415**		

Specimen Bulk Specific Gravity

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

$$G_{mb} \text{ Specimen 1} \quad \frac{4790.5}{(4795.0 - 2810.0)} = \frac{4790.5}{1985.0} = \mathbf{2.413}$$

$$G_{mb} \text{ Specimen 2} \quad \frac{4791.4}{(4794.9 - 2813.3)} = \frac{4791.4}{1981.6} = \mathbf{2.418}$$

$$G_{mb} \text{ Specimen 3} \quad \frac{4789.1}{(4792.4 - 2809.2)} = \frac{4789.1}{1983.2} = \mathbf{2.459}$$

$$\text{Avg. } G_{mb} \quad \frac{G_{mb}\text{ Specimen 1} + G_{mb}\text{ Specimen 2} + G_{mb}\text{ Specimen 3}}{3}$$

$$\text{Avg. } G_{mb} \quad \frac{2.454 + 2.458 + 2.459}{3} = \frac{7.246}{3} = \mathbf{2.415}$$

2A. Calculate the Effective Specific Gravity of the Aggregate (G_{se}) = **2.719**

[100% (total sample) - % asphalt content] = P_s

100 – 5.01 = **94.60**

$$G_{se} = \frac{P_s}{\left(\frac{100}{G_{mm}}\right) - \left(\frac{P_b}{G_b}\right)} \qquad G_{se} = \frac{94.60}{\left(\frac{100}{2.498}\right) - \left(\frac{5.40}{1.030}\right)} = \frac{94.60}{40.03 - 5.24} = \frac{94.60}{35.84} = \mathbf{2.719}$$

2B. Calculate the Bulk Specific Gravity of the Aggregate (G_{sb}) = **2.696**

$G_{sb} = G_{se} - CF$ 2.719 – 0.023 = **2.696**

3. Calculate the VTM, VMA, VFA, and F/A ratio for this mix.

VTM

$$VTM = 100 \times \left[1 - \left(\frac{Avg.\ G_{mb}}{G_{mm}}\right)\right]$$

$$VTM = 100 \times \left[1 - \left(\frac{2.415}{2.498}\right)\right]$$ VTM = 100 x (1 – 0.967) VTM = 100 x 0.033 = **3.3**

VMA

$$VMA = 100 - \left[\left(\frac{G_{mb} \times P_s}{G_{sb}}\right)\right]$$

$$VMA = 100 - \left[\left(\frac{2.415 \times 94.60}{2.696}\right)\right]$$ $$VMA = 100 - \frac{228.46}{2.696}$$ VMA = 100 - 84.7 = **15.3**

VFA

$$VFA = \left[\left(\frac{VMA - VTM}{VMA}\right)\right] \times 100$$

$$VFA = 100 \times \left[\left(\frac{15.3 - 3.3}{15.3}\right)\right]$$ $$VFA = 100 \times \frac{12}{15.3}$$ VFA = 100 x 0.784 = **78**

F/A Ratio - First must calculate the effective Asphalt Content (P_{be})

$$P_{be} = P_b - \left[(P_s \times G_b) \times \left(\frac{(G_{se} - G_{sb})}{(G_{se} \times G_{sb})} \right) \right]$$

$$P_{be} = 5.40 - \left[(94.6 \times 1.03) \times \left(\frac{2.719 - 2.696}{2.719 \times 2.696} \right) \right]$$

$$P_{be} = 5.40 - \left[(97.44) \times \left(\frac{0.023}{7.330} \right) \right]$$

$$P_{be} = 5.40 - [\,97.44 \times 0.003\,]$$

$$P_{be} = 5.40 - 0.29$$

$$P_{be} = \mathbf{5.11}$$

$$\text{F/A Ratio} = \frac{\text{\% passing 200 sieve}}{P_{be}}$$

$$\text{F/A Ratio} = \frac{6.0}{5.11}$$

F/A Ratio = **1.2**

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4. Do all the volumetric properties meet the mix design criteria for this mix <u>during production</u>?

Design Range Criteria: Specification Criteria, Calculated Results:

Design Range Criteria	Specification Criteria	Calculated Results	Meet Spec.?
VTM	**2.0 – 5.0**	**3.3**	**Yes**
VMA	**Min. 13**	**15.3**	**Yes**
VFA	**64 - 81**	**78**	**Yes**
F/A	**0.6 – 1.2**	**1.2**	**Yes**

Chapter Ten: Quality Acceptance and Data Processing

1.	A mathematical analysis of accumulated data is called:	B. Statistics
2.	The job mix formula with the tolerance applied is the:	B. Acceptance range
3.	The quantity of material to be checked for compliance with specifications is called:	B. A lot
4.	The job mix formula is chosen from the:	B. Design range
5.	A reduction in the unit bid price of material is known as:	C. A price adjustment
6.	When the normal daily production of the source from which asphalt concrete is being obtained is in excess of 4000 tons, the lot size may be increased to:	C. 8000 tons
7.	Standard deviation computations are not normally made on more than two job mixes for the same type material on a single project.	A. True
8.	The amount of deviation allowed from the job mix formula is known as the:	B. Process tolerance
9.	How many adjustment points may a material have and still remain in the road?	C. 25 or less
10.	Variability can be computed on any number of samples except:	A. One
11.	Would the process tolerance be the same for three tests as a lot with four tests?	B. No
12.	After running analysis on a sample, how is it checked for conformity with specifications?	The average of four results is compared to the job mix, individual test results are not
13.	On a failing lot, who is responsible for applying the adjustment points?	District Materials Engineer

14. If a job mix is in the design range, can it be disapproved?	Yes, if the mix will not meet specification requirements such as density
15. Where are the standard deviation limits found for asphalt concrete?	Section 211.09 Table II-16
16. What number of adjustment points constitutes the removal of the material from the road?	More than 25 (Section 211.09)
17. Why is it important that a Producer know what the product variability is at all times?	In order to know whether his process is in control
18. Calculations for the gradation of aggregate in the mixture are shown to what percent? The asphalt content to what percent?	Aggregate to the nearest tenth. Asphalt to the nearest hundredth.
19. What, if any adjustment points would be applied to a mix if the standard deviation for the No.200 material is 2.3?	Two (2) adjustment points

Problem No.1 Answers

TL-100A
REV: 03/2010

VIRGINIA DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION
ASPHALT CONCRETE - TEST RESULTS INPUT FORM

INPUT SUBMITTED BY: | DATE SUBMITTED: | PHONE NUMBER:
PLANT ID: 1048

JOB MIX NUMBER:	201003	PROJECT # :	TONS:	PROJECT # :	TONS:
LOT:	201007	PM-1L-05	2000		
MIX TYPE:	SMA-12.5				
MIX CODE:	15				

REPORT #

SAMPLE #	TON	DATE MMDDYY	TIME HH:MM	2 in	1.5 in.	1 in.	3/4 in.	1/2 in.	3/8 in.	#4	#8	#30	#50	#200	A.C.	TEMP	C F	MIX TIME	ASPH CEM.	VDOT
1	210	8/27/2010	10:00	100%	100%	100%	100%	98%	87%	0%	49%	0%	0%	5.3%	5.63%	310	F	27	23	x
2	710	8/27/2010	13:30	100%	100%	100%	100%	99%	84%	0%	47%	0%	0%	4.7%	5.57%	310	F	27	23	
3	1224	8/28/2010	8:17	100%	100%	100%	100%	99%	81%	0%	44%	0%	0%	5.7%	5.06%	305	F	27	23	x
4	1820	8/28/2010	11:05	100%	100%	100%	100%	99%	87%	0%	50%	0%	0%	5.5%	5.15%	308	F	27	23	
5																				
6																				
7																				
8																				

Volumetric Data	VTM	VMA	VFA	F/be	Gmm	VCAmix (SMA Only)	Comments
1	4.40%	16.2%	72.8%	1.00	2.479		
2							
3	3.61%	15.3%	76.4%	1.20	2.494		
4							
5							
6							
7							
8							

Problem No. 2 Answers: Failure and Adjustment

Using the information given below, calculate the failure and adjustment. The producer is Flatt Top Paving Company and the plant is a batch plant and operates on a 27 second wet mixing time. It has been assigned to Code Number 777. The material is being shipped to Schedule No. 777-75, Item N. The asphalt cement is delivered from terminal No. 15. The samples represent Lot 1, which contains 2000 tons.

Job Mix Information: **Type SM-12.5A**

Mix code number - 16

Job Mix Number - 9202

Job Mix	
3/4 in	100.0
1/2 in	97.0
3/8 in	88.0
No. 8	55.0
No. 200	5.5
A.C.	5.50

Test Results:	Sample #1	Sample #2	Sample #3	Sample # 4	Avg.	Acc. Range	P/F
Date	8-27-10	8-27-10	8-28-10	8-28-10			
Time	10:00	13:30	8:17	11:05			
Ton	210	710	1224	1820			
Mix Temp.	310 °F	310 °F	305 °F	308 °F			
3/4 in	100.0	100.0	100.0	100.0	**100.0**	**100.0**	**P**
1/2 in	98.4	99.4	98.5	99.2	**98.9**	**93 - 100**	**P**
3/8 in	87.1	83.5	81.1	87.3	**85**	**84 - 92**	**P**
No. 8	48.7	46.7	44.2	50.2	**47.5**	**51 - 59**	**P**
No. 200	5.3	4.7	5.7	5.5	**5.3**	**4.5 – 6.5**	**P**
A.C.	5.63	5.57	5.06	5.15	**5.35**	**5.20 - 5.80**	**P**

Acceptance Range Calculations

	Mix Design	Tolerance	Lower Range	Upper Range
3/4 in	100.0			
1/2 in	97.0	**± 4**	**97.0 – 4 = 93**	**97.0 + 4 = 101 100**
3/8 in	88.0	**± 4**	**88.0 – 4 = 84**	**88.0 + 4 = 92**
No. 8	55.0	**± 4**	**55.0 – 4 = 51**	**55.0 + 4 = 59**
No. 200	5.5	**± 1**	**5.5 – 1 = 4.5**	**5.5 +1 = 6.5**
A.C.	5.50	**± .30**	**5.50 - .30 = 5.20**	**5.50 + .30 = 5.80**

No. 8 sieve

51.0	lower acc.	1.0	adj. for each 1%
- 47.5	avg. test result	X 3.5	outside accept range
3.5	outside accept. range	3.5%	adj. for # 8

Problem No. 3 Answers: Computing Standard Deviation

Using the information given below, determine the variability of the # 200 sieve.

Test Results:	**Sample #1**	**Sample #2**	**Sample #3**	**Sample #4**
Date	8-27-10	8-27-10	8-28-10	8-28-10
Time	10:00	13:30	8:17	11:05
Ton	210	710	1224	1820
Mix Temp.	310°F	310°F	305°F	308°F
3/4 in	100.0	100.0	100.0	100.0
1/2 in	98.4	99.4	98.5	99.2
3/8 in	87.1	83.5	81.1	87.3
No. 8	48.7	46.7	44.2	50.2
No. 200	5.3	4.7	5.7	5.5

$$\sigma = \sqrt{\frac{\sum (X - \overline{X})^2}{n - 1}}$$

n	X	$\overline{X}$	$X - \overline{X}$	$(X - \overline{X})^2$
1	**5.3**	**5.3**	**0.00**	**0.00**
2	**4.7**	**5.3**	**-0.60**	**0.36**
3	**5.7**	**5.3**	**0.40**	**0.16**
4	**5.5**	**5.3**	**0.20**	**0.04**
Sum =	**21.20**		**0.00**	**.56**

$$\frac{21.20}{4} = 5.3$$

5.3 – 5.3 = 0.00

4.7 – 5.3 = - 0.60

5.7 – 5.3 = 0.40

5.5 – 5.3 = 0.20

$$\sigma = \sqrt{\frac{\sum (X - \overline{X})^2}{n - 1}}$$

$$\sigma = \sqrt{\frac{0.56}{3}}$$

$$\sigma = \sqrt{0.186666}$$

σ = **0.43 Meets Specification**

Problem No. 4 Answers: Computing Price Adjustment for Variability as measured by Standard Deviation

A. Complete the following test report and if the material fails, indicate area(s) of failure. If the material can be accepted with adjustment, calculate the percent of adjustment.

						Accept. Range			
Sample #	**1**	**2**	**3**	**4**	**Aver.**	**Lower**	**Upper**	**Job-Mix**	**P/F**
1 1/2 in	100.0	100.0	100.0	100.0	**100.0**	**96.0**	**100.0**	100.0	**P**
1 in	97.2	100.0	98.4	99.3	**97.0**	**94.0**	**100.0**	98.0	**P**
3/4 in	73.1	78.2	79.2	75.1	**76.2**	**72.0**	**80.0**	76.0	**P**
No. 8	29.2	32.1	28.3	36.2	**31.4**	**29.0**	**37.0**	33.0	**P**
No. 200	3.2	5.6	4.7	3.9	**4.3**	**3.0**	**5.0**	4.0	**P**
A.C.	4.68	4.83	5.00	5.27	**4.95**	**4.10**	**4.70**	4.40	**F**

Acceptance Range Calculations

	Mix Design	Tolerance	Lower Range	Upper Range
1 ½ in	100.0	±4	100 – 4 = 96.0	100.0 + 4 = ~~104~~ 100.0
1 in	98.0	±4	98.0 – 4 = 94.0	98.0 + 4 = ~~102~~ 100.0
3/4 in	76.0	±4	76.0 – 4 = 72.0	76.0 + 4 = 80.0
No. 8	33.0	± 4	33.0 – 4 = 29.0	33.0 + 4 = 37.0
No. 200	4.0	± 1	4.0 – 1 = 3.0	4.0 + 1 = 5.0
A.C.	4.40	± .30	4.40 - .30 = 4.10	4.40 + .30 = 4.70

4.95	average asphalt content	10	adj. for each 1%
- 4.70	upper accept. range	X 0.25	outside accept range
0.25%	outside accept. range	2.5%	% adjustment

B. Using the test report above, determine the variability of the No. 8 (2.36mm) sieve by calculating the standard deviation. Determine if the variability meets the specification requirements. If not, how many adjustment points would be applied?

$$\sigma = \sqrt{\frac{\sum (X - \bar{X})^2}{n - 1}}$$

n	X	$\bar{X}$	$X - \bar{X}$	$(X - \bar{X})^2$
1	29.2	31.45	-2.25	5.06
2	32.1	31.45	0.65	0.42
3	28.3	31.45	-3.15	9.92
4	36.2	31.45	4.75	22.56
Sum =	125.8		0.00	37.96

$$\frac{125.8}{4} = 31.45$$

29.2 – 31.45 = -2.25

32.1 – 31.45 = 0.65

28.3 – 31.45 = -3.15

36.2 – 31.45 = 4.75

$$\sigma = \sqrt{\frac{\sum (X - \bar{X})^2}{n - 1}}$$

$$\sigma = \sqrt{\frac{37.96}{3}}$$

$$\sigma = \sqrt{12.653333}$$

σ = **3.6 Does not meet specifications, 1 adjustment point applied.**

Problem No. 5 Answers: Computing Price Adjustment for Variability as measured by Standard Deviation

A. Complete the following test report and if the material fails, indicate area(s) of failure. If the material can be accepted with adjustment, calculate the percent of adjustment.

					Accept. Range			
Sample #	**1**	**2**	**3**	**Aver.**	**Lower**	**Upper**	**Job-Mix**	**P/F**
1 1/2 in	100.0	100.0	100.0	**100.0**	**100.0**	**100.0**	100.0	**P**
1 in	94.3	97.7	99.1	**97.0**	**93.6**	**100.0**	98.0	**P**
3/4 in	73.5	76.1	78.9	**76.2**	**71.6**	**80.4**	76.0	**P**
No. 8	28.5	35.1	30.7	**31.4**	**28.6**	**37.4**	33.0	**P**
No. 200	3.6	4.9	4.3	**4.3**	**2.9**	**5.1**	4.0	**P**
A.C.	4.67	4.82	4.91	**4.80**	**4.07**	**4.73**	4.40	**F**

Acceptance Range calculations

	Mix Design	**Tolerance**	**Lower Range**	**Upper Range**
1 ½ in	100.0	±4.4	100 – 4.4 = 95.6	100.0 + 4.4 = 104.4 100.0
1 in	98.0	±4.4	98.0 – 4.4 = 94.0	98.0 + 4.4 = 102.4 100.0
3/4 in	76.0	±4.4	76.0 – 4.4 = 71.6	76.0 + 4.4 = 80.4
No. 8	33.0	±4.4	33.0 – 4.4 = 28.6	33.0 + 4.4 = 37.4
No. 200	4.0	± 1.1	4.0 – 1.1 = 2.9	4.0 + 1.1 = 5.1
A.C.	4.40	± .33	4.40 – .33 = 4.07	4.40 + .33 = 4.73

4.80	average asphalt content	10	adj. for each 1%
- 4.73	upper accept. range	X 0.07	outside accept range
0.07	outside accept. range	0.7 %	price adjustment

B. Using the test report above, determine the variability of the No. 8 (2.36mm) sieve by calculating the standard deviation. Determine if the variability meets the specification requirements. If not, how many adjustment points would be applied?

$$\sigma = \sqrt{\frac{\sum (X - \overline{X})^2}{n - 1}}$$

N	X	$\overline{X}$	$X - \overline{X}$	$(X - \overline{X})^2$
1	28.5	31.433	-2.933	8.6025
2	35.1	31.433	3.667	13.4469
3	30.7	31.433	-0.733	0.5373
Sum =	94.3		0.001	22.5867

$$\frac{94.3}{3} = 31.433$$

28.5 – 31.433 = - 2.933

35.1 – 31.433 = 3.667

30.7 – 31.433 = - 0.733

$$\sigma = \sqrt{\frac{\sum (X - \overline{X})^2}{n - 1}}$$

$$\sigma = \sqrt{\frac{22.5867}{2}}$$

$$\sigma = \sqrt{11.2934}$$

σ = 3.36 Does not meet specifications, 1 adjustment point applied.

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