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The homework questions in this packet are similar to the ones found on the actual written exam. The attached formula sheet may be used during testing. Several problems refer to a mix design which is also attached at the back of this packet. Answers to the problems are given on the last page of the packet so that you may check your work.

1. An asphalt mixture contains 115.7 g of binder and 2573.5 g of aggregate. Determine the % binder and % stone of the mixture to the nearest 0.1 %.

2. The binder content for several asphalt samples are shown below. Determine the % stone in each of the mixtures.

Pb	Ps
4.6 %	

Pb	Ps
5.7 %	

Pb	Ps
6.2 %	

3. Asphalt binder is being supplied for three different jobs at an asphalt plant. The binder is coming from different manufacturers for each job. Based on the information on the load tickets, determine the specific gravity of the binder needed for calculations at the asphalt plant for each job.

Job	Tank	Load Ticket	Gb
1	1	Gb_{60} 1.034	
2	5	Gb_{77} 1.030	
3	2	Gb_{60} 1.031	

4. You have compacted two gyratory specimens in the lab. Bulk specific gravity data collected using AASHTO T 166 is shown below. Determine the bulk specific gravity and % absorption of each specimen.

Specimen # 1		Specimen # 2	
Dry Mass	4660.4 g	Dry Mass	4663.3
Sub. Mass	2650.5 g	Sub. Mass	2651.8
SSD Mass	4666.3 g	SSD Mass	4672.7

5. You have run a Gmm sublot test on plant produced HMA and collected the following data. Determine the Gmm and Gse of the asphalt mixture.

Mass of Empty Vacuum Bowl	2850.4 g	Gb @ 60°F	1.034
Mass of Bowl with Sample	4718.9 g		
Sub. Mass of Vacuum Bowl + Sample	2418.3 g	Pb	5.7 %
Sub. Mass of Vacuum Bowl	1322.0 g		

6. Use the results from questions 4 and 5 to determine the **reported** % air voids for the sublot.

Average Gmb _____

Gmm _____

7. Use the data and results from questions 4, 5 and 6 above to calculate the VMA effective and **reported** VMA for the mix. *(Hint: look up VMA CF on the supplied mix design)*

Average Gmb	_____	Ps	_____%
Gse	_____	Pb	_____ %
Gmm	_____	VMA CF	_____

8. An 8000 g batch of aggregate was added to a mixing pot. The actual weight of aggregate is found to be 7997.2 g. The % of binder to be added is 5.8 %. Determine the total weight of mixture or the weight of asphalt to be added to the mixing pot.

9. Determine the batch weights necessary to produce 9,000 g aggregate batches for an ARDOT AC Gauge calibration at the required binder contents for the supplied mix design. Record values to the nearest 0.1 g.

Aggregate Cold Feed		Agg. Weight
3/4” Chip		
1/2" Chip		
3/8” Gravel		
Ind. Sand		
Screenings		

% Binder	% Stone	Binder Weight

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10. Determine the aggregate and binder weights necessary to prepare an ignition oven calibration sample for the supplied mix design that requires a mix weight of 1750.0 g. Record values to the nearest 0.1 g.

Design binder content:		_____%	_____
Aggregates:	3/4" Chip	_____%	_____
	1/2” Chip	_____%	_____
	3/8” Gravel	_____%	_____
	Ind. Sand	_____%	_____
	Screenings	_____%	_____

11. From the following ignition oven calibration data, determine the reported ignition oven binder calibration factor for the supplied mix design.

Burn 1	
Elapsed Time:	37:45
Sample Weight:	1677g
Weight Loss:	95.4g
Percent Loss:	5.69%
Temp Comp:	0.17%
Calib. Factor:	0.00%
Calibrated Asphalt Ctnt	
5.52%	

Burn 2	
Elapsed Time:	41:26
Sample Weight:	1663g
Weight Loss:	95.5g
Percent Loss:	5.74%
Temp Comp:	0.14%
Calib. Factor:	0.00%
Calibrated Asphalt Ctnt	
5.60%	

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12. From the following ignition oven calibration data, determine the reported ignition oven calibration factor.

Design Binder Content	6.0 %	
Ignition Oven % Binder (1) @ 538 °C	7.33 %	
Ignition Oven % Binder (2) @ 538 °C	7.45 %	
Ignition Oven % Binder (3) @ 482 °C	6.55 %	
Ignition Oven % Binder (4) @ 482 °C	6.61 %	

13. From the following ignition oven calibration data, determine the reported ignition oven calibration factor.

Design Binder Content	5.5 %	CF
Ignition Oven % Binder (1) @ 482 °C	5.63 %	
Ignition Oven % Binder (2) @ 482 °C	5.80 %	
Ignition Oven % Binder (3) @ 482 °C	5.84 %	
Ignition Oven % Binder (4) @ 482 °C	5.72 %	

14. A laboratory wants to use the aggregate left after an ignition oven burn to determine the gradation of their field produced HMA. Use the data below to determine the aggregate correction factor for each sieve and calculate the % passing for the field gradation.

Sieve	Blank	Burn # 1	Burn # 2	Average Burn	ACF	Allowed	Sieve Analysis	Calculated % Passing
3/4”	100.0	100.0	100.0			± 5 %	100.0	
1/2"	96.0	96.5	97.0			± 5 %	96.9	
3/8”	87.0	89.0	89.4			± 5 %	89.5	
# 4	55.0	58.4	58.8			± 5 %	58.8	
# 8	35.0	41.2	40.0			± 5 %	40.9	
# 16	27.0	29.8	29.0			± 3 %	29.8	
# 30	17.0	19.7	19.5			± 3 %	20.0	
# 50	13.0	14.5	14.8			± 3 %	14.5	
# 100	9.0	10.7	10.9			± 3 %	11.1	
# 200	5.2	5.6	5.6			± 0.5 %	5.8	

15. Use the ignition oven burn data given below to determine the reported % passing for each sieve.

Sieve	Sieve Analysis	ACF	Calculated % Passing	Reported % Passing
3/4”	100.0	0.0		
1/2"	97.2	- 1.8		
3/8”	83.1	- 2.1		
# 4	60.8	- 3.3		
# 8	42.5	- 2.0		
# 16	31.0	- 1.5		
# 30	22.5	- 1.4		
# 50	14.6	- 1.2		
# 100	10.0	- 1.1		
# 200	5.0	- 0.7		

16. Calculate the application rate (lb / yd^2) for 2000 tons of hot mix asphalt laid 14 feet wide from station 193 + 00 to station 251 + 76.

17. Determine the tons of asphalt required to surface a driveway area 12’ wide and 450‘ long if the application rate is to be 220 lb / yd^2.

18. The following questions pertain to the supplied mix design.

a. What is the ARDOT mix design number?
b. What is the temperature required for compaction of gyratory specimens?
c. What is the required number of gyrations for quality control?
d. What is the maximum temperature that reduction equipment may be heated to?

19. Moisture content data collected for an asphalt test is shown below. Determine the moisture content of the sample. *Note: The value may be higher than normal.*

Tare weight of pan:	164.8 g
Weight of "wet" sample & pan:	1203.5 g
Weight of "dry" sample & pan:	1195.0 g

20. Binder content readings obtained from an asphalt content gauge and ignition oven are shown below along with their respective moisture contents. Determine the **reported** binder content of each of the asphalt mixtures.

Test	Reading	% Moisture	Calc. Pb	Reported Pb
AC Gauge	5.25 %	0.02 %		
Ignition Oven	4.76 %	0.07 %		

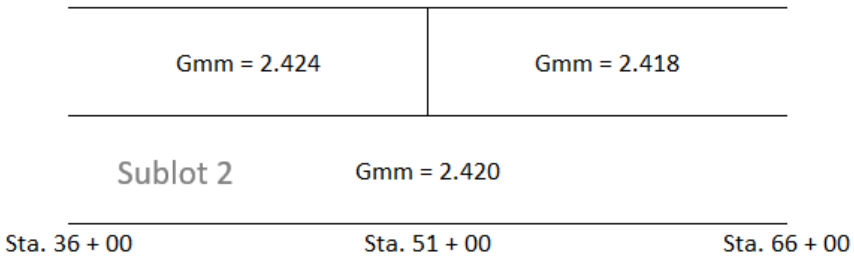
21. The weight of an asphalt mixture prior to solvent washing is 2364.2 g and the reported binder content is 5.6 %. Determine the weight of aggregate needed for calculating the sieve analysis.

22. Determine the total number of passes (any kind) required for a rolling pattern from the following information.

Pass	Type	Density (WD)
1	Vibratory	133.2 pcf
2	Vibratory	136.5 pcf
3	Static	139.7 pcf
4	Static	140.6 pcf
5	Static	136.0 pcf

23. A core with a Gmb of 2.306 has been cut from an asphalt pavement. Calculate and **report** the % compaction for the pavement if the Gmm is 2.417.

24. Joint densities are required on an ARDOT project. Determine the joint core location for Sublot 2 using a random number of 0.22.



25. Use the Gmm information from question 10 to calculate the % compaction for the joint core. The Gmb of the joint core was found to be 2.212.

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HMA Formulas

$$P_b + P_s = 100$$

$$Mix\ Wt = \frac{Agg\ Wt}{P_s}\ x\ 100\ \%$$

$$P_s = \frac{Agg\ Wt}{Mix\ Wt}\ x\ 100\ \%$$

$$P_b = \frac{Binder\ Wt}{Mix\ Wt}\ x\ 100\ \%$$

$$G_{b_{77}} = \left(G_{b_{60}}\right)(0.9941)$$

$$\%\ MC = \frac{\left(M_i - M_f\right)}{M_f}\ x\ 100\ \%$$

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

$$\%\ Abs = \frac{(B - A)}{(B - C)}\ x\ 100\ \%$$

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

$$G_{se} = \frac{P_s}{\left(\frac{100}{G_{mm}} - \frac{P_b}{G_b}\right)}$$

$$VMA_e = 100 - \frac{(G_{mb})(P_s)}{G_{se}}$$

$$VMA = VMA_e - VMA_{CF}$$

$$\%\ Compaction = \frac{G_{mb}}{G_{mm}}\ x\ 100\ \%$$

$$Rate = \frac{(tons)(18{,}000)}{(length)(width)}$$

$$Tons = \frac{(Rate)(length)(width)}{18{,}000}$$

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January 1, 2020

Project Number : CTTP

Gentlemen :

The mix design for the 12.5 mm ACHM Surface is accepted. Our average verification results on this mix design are: Air Voids – 4.3 %; Gmb – 2.310; Height at Ndes – 114.8 mm. This mix design will be identified as HMA000-20 for the Hogville plant in Fayetteville, AR.

Mix Design Expiration Date: 1/1/2025

	Mix Design Properties	Allowable Field Tolerances
Optimum Asphalt Binder:	5.4 %	5.1 % to 5.7 %
Air Voids:	4.0 %	3.0 % to 5.0 %
VMA:	14.5 %	13.5 % to 16.0 %
VFA:	73.1 %	
Fines to Asphalt Ratio:	0.99	
Retained Stability:	96.1 %	
Nmax:	205	
Asphalt Binder:	HOG OIL PG 76-22	
APA Results:	1.055 mm	5.000 mm or less

If you have any questions, please contact the Materials Division at the above postal address, or phone (XXX) XXX-HOGS.

Sincerely,

Boss Hog
Materials Engineer

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Volumetric Mix Design

Mix Design #:	HMA000-20	Date Accepted:	1/1/20
Mix Type:	12.5 MM ACHM Surface	Mix Design Expiration Date:	1/1/2025
Plant:	Hogville		
Plant Location:	Fayetteville, AR		
Mix Designed By:	All Hogs Lab, Fayetteville, AR		

No.	*Aggr. ID*	*Aggr. Name*	*Source*	
1	7500	3/4" Chip	Hogville Group, Hog Quarry	Fayetteville, AR
2	5000	1/2" Chip	Hogville Group, Hog Quarry	Fayetteville, AR
3	3750	3/8" Gravel	Hogville Group, Hog S & G	Fayetteville, AR
4	2200	Ind. Sand	Hogville Group, Hog Quarry	Fayetteville, AR
5	2000	Screenings	Hogville Group, Hog Quarry	Fayetteville, AR

Aggregates

Sieve Size	1	2	3	4	5	Job Mix	Control Points
50	100	100	100	100	100	**100**	100%
37.5	100	100	100	100	100	**100**	100%
25	100	100	100	100	100	**100**	100%
19	100	100	100	100	100	**100**	100%
12.5	74	100	100	100	100	**95**	90-100%
9.5	47	91	100	100	99	**87**	90% Max
4.75	5	21	96	94	80	**54**	
2.36	3	3	76	65	61	**36**	28-58%
1.18	3	3	51	43	49	**26**	
0.6	3	3	32	25	41	**18**	
0.3	3	3	17	16	32	**12**	
0.15	2	2	8	14	22	**8**	
0.075	1.5	1.0	3.5	10.0	12	**4.6**	2-10%
Cold Feed%	20	29	22	15	14		
Gsb	2.520	2.616	2.559	2.496	2.544		

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Volumetric Mix Design

Design Summary

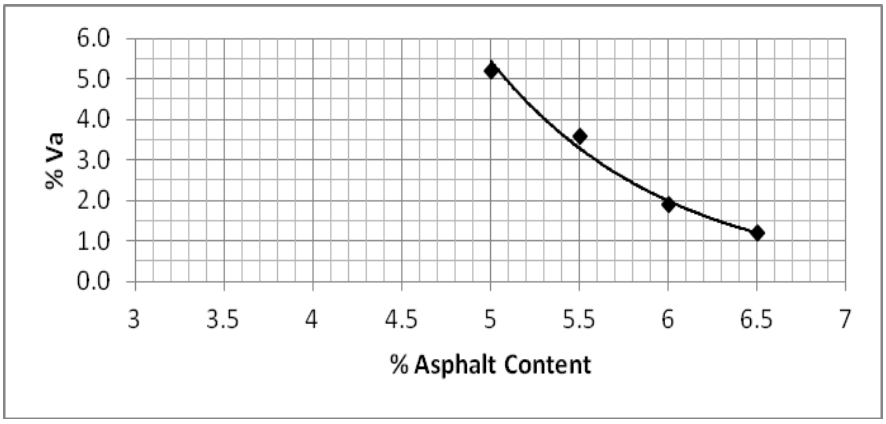
Mix Design #: HMA000-20 Mix Type: 12.5 MM ACHM Surface

Total Asphalt Content %:	5.4	Air Voids (Va):	4.0
		VMA:	14.7
Max. Theor. SG (Gmm):	2.400	VMA Corr. Factor:	1.5
Asphalt Binder:	PG 76-22	Gsb:	2.556
Asphalt Binder Source:	Hog Oil Company	Gse:	2.601
Mixing Temp (F):	340	Gb:	1.020
Compaction Temp (F):	310		
Antistrip Source:	HogGrip 975	Ni:	9
Antistrip %:	0.25	Nd:	125
% Retained Stability:	96.1	Nm:	205

Loaded Wheel Test (LWT) Data (mm) = 4.818 Spec Max = 8.000 mm

Summary of Mix Compaction Properties

Pb	% Gmm @ Ni	% Va	% Vma	% Vfa	F/A	Gmm
5	84.9	5.2	14.8	64.9	1.08	2.417
5.5	86.2	3.6	14.4	75.2	0.97	2.400
6	87.7	1.9	14.0	86.5	0.88	2.383
6.5	88.1	1.2	14.5	91.8	0.80	2.366



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Answer Sheet

1. Pb = 4.3 % Ps = 95.7 %

2. 95.4 % 94.3 % 93.8 %

3. 1.028 1.030 1.025

4. Gmb 1 = 2.312 % Abs 1 = 0.29 %
Gmb 2 = 2.308 % Abs 2 = 0.47 %

5. Dry Mass (A) = 1868.5 Sub. Mass (C) = 1096.3
Gmm = 2.420 Gb_{77} = 1.028 Gse = 2.636

6. 4.5 %

7. VMAe = 17.4 % VMA = 15.9 %

8. Weight of Mix = 8489.6 g Weight of Binder = 492.4 g

9.

Aggregate Cold Feed		Agg. Weight
3/4” Chip	20 %	1800.0
1/2" Chip	29 %	2610.0
3/8” Gravel	22 %	1980.0
Ind. Sand	15 %	1350.0
Screenings	14 %	1260.0

% Binder	% Stone	Binder Weight
0.0	100.0	0.0
4.4	95.6	414.2
5.4	94.6	513.7
6.4	93.6	615.4

10.

Binder	5.4 %	94.5
3/4” Chip	20 %	331.1
1/2” Chip	29 %	480.1
3/8” Gravel	22 %	364.2
Ind. Sand	15 %	248.3
Screenings	14 %	231.8

11. 0.16

12. 0.58

13. 0.26

Answer Sheet

14.

Sieve	Blank	Burn # 1	Burn # 2	Average Burn	ACF	Sieve Analysis	Calculated % Passing
3/4”	100.0	100.0	100.0	100.0	0.0	100.0	100.0
1/2"	96.0	96.5	97.0	96.8	-0.8	96.9	96.1
3/8”	87.0	89.0	89.4	89.2	-2.2	89.5	87.3
# 4	55.0	58.4	58.8	58.6	-3.6	58.8	55.2
# 8	35.0	41.2	40.0	40.6	-5.6	40.9	35.3
# 16	27.0	29.8	29.0	29.4	-2.4	29.8	27.4
# 30	17.0	19.7	19.5	19.6	-2.6	20.0	17.4
# 50	13.0	14.5	14.8	14.7	-1.7	14.5	12.8
# 100	9.0	10.7	10.9	10.8	-1.8	11.1	9.3
# 200	5.2	5.6	5.6	5.6	-0.4	5.8	5.4

15.

Sieve	Sieve Analysis	ACF	Calculated % Passing	Reported % Passing
3/4”	100.0	0.0	100.0	100
1/2"	97.2	- 1.8	97.2	97
3/8”	83.1	- 2.1	83.1	83
# 4	60.8	- 3.3	60.8	61
# 8	42.5	- 2.0	42.5	43
# 16	31.0	- 1.5	31.0	31
# 30	22.5	- 1.4	22.5	23
# 50	14.6	- 1.2	14.6	15
# 100	10.0	- 1.1	10.0	10
# 200	5.0	- 0.7	4.3	4.3

16. 438 lb/yd²

17. 66 tons

Answer Sheet

18. a. HMA 000-20 b. 310 °F c. 125 d. 340 °F

19. 0.83 %

20. 5.2 %
4.7 %

21. 2231.8 g

22. 4 Passes

23. 95.4 %

24. Sta. 42 + 60

25. 91.3 %