Example Problems Packet

Hot Mix Testing Recertification

Quality Control / Quality Assurance

SD DEPARTMENT OF TRANSPORTATION

PERCENT RECLAIMED ASPHALT PAVEMENT (RAP) IN THE MIX AS PERCENT OF TOTAL AGGREGATE

WEIGH TICKET ENTRIES

$$C = \frac{A \times \left(\frac{B}{100}\right)}{\left[1 + \left(\frac{B}{100}\right)\right]}$$

$$D = A - C$$

$$F = A \times \left(\frac{E}{100}\right)$$

$$H = A \times \left(\frac{G}{100}\right)$$

$$I = D - (F + H)$$

WEIGH BRIDGE ENTRIES

$$L = \frac{J \times \left(\frac{K}{100}\right)}{\left[1 + \left(\frac{K}{100}\right)\right]}$$

$$M = J - L$$

$$P = \frac{N \times \left(\frac{O}{100}\right)}{\left[1 + \left(\frac{O}{100}\right)\right]}$$

$$Q = N - P$$

$$R = M + Q$$

RAP PERCENTAGES

$$S = \left(\frac{Q}{R}\right) \times 100$$

$$T = \left(\frac{Q}{I}\right) \times 100$$

$$U = \left(\frac{I - R}{I}\right) \times 100$$

Gmm = maximum specific gravity of paving mix

Gsb = bulk specific gravity of mineral aggregate

Pb = percent asphalt binder content

Gmb = bulk specific gravity of compacted mix

Gb = specific gravity of asphalt binder

DOT-86 Equations

Gse (Effective specific gravity of mineral aggregate)	=	$\frac{100 - Pb}{\left(\frac{100}{Gmm}\right) - \left(\frac{Pb}{Gb}\right)}$
Va (Percent Air Voids)	=	$\left(\frac{Gmm - Gmb}{Gmm}\right) \times 100$
Ps (Percent aggregate content of mixture)	=	$100 - Pb$
VMA (Voids in the Mineral Aggregate)	=	$100 - \left(\frac{Gmb \times Ps}{Gsb}\right)$
VFA (Voids Filled with Asphalt)	=	$\left(\frac{VMA - Va}{VMA}\right) \times 100$
Pba (Percent asphalt absorption)	=	$100 \times \left(\frac{Gse - Gsb}{Gse \times Gsb}\right) \times Gb$
Pbe (Percent effective asphalt content)	=	$Pb - \left(\frac{Pba \times Ps}{100}\right)$
Dust to Binder Ratio	=	$\left(\frac{\% - \#200 \text{ material} + \% \text{ hydrated lime}}{Pbe}\right)$
Gmb x	=	$\left(\frac{Gmb_{(measured)} \times height_{(measured)}}{height\ x}\right)$
Calculation for G_{mb} bulk specific gravity of compacted mix at any given gyration point in the compaction process when x is number of gyrations such as at N_{ini} or N_{des}		
% of Gmm (Percent of mixture theoretical maximum specific gravity)	=	$\left(\frac{Gmb}{Gmm}\right) \times 100$

Problem #1

Asphalt Binder Content (SD 314)

Complete the DOT-89 form below. What is the Job Mix Formula Tolerance? _____

TANK METHOD

A. Beginning Specific Gravity of Bitumen @ 60°F	1.035
B. Beginning Weight Per Gallon @ 60°F	8.630
C. Temperature of Bitumen in Tank When Check Starts	295*
D. Weight Per Gallon of Bitumen at Temperature	
E. Gallons in Tank When Check Starts (calibrated stick)	29272
Gallons at Start (at start of tank use)	☐
f. Weight of Bitumen in Tank (start check) (D x E / 2000)	
G. Weight of Bitumen Added to Tank(s)	
H. Temperature of Bitumen in Tank When Check Ends	295*
I. Gallons in Tank When Check Ends (calibrated stick)	29094
J. Ending Specific Gravity of Bitumen @ 60°F	1.035
K. Ending Weight Per Gallon @ 60°F	8.630
L. Weight Per Gallon at Temperature	
M. Weight of Bitumen in Tank (end check) (I x L / 2000)	
Left in Storage (at end of tank use)	☐
N. Weight of Bitumen Used (F + G - M)	
O. Weight of Mix Produced (Tons)	
P. Percent Bitumen in Mix (N / O x 100)	

*Temp. Correction Factor Chart in SD 314

G. Load #	Invoice #	Tons
1	10007	26.80
2	10009	26.47
3	10012	33.79
4	10017	40.64
5	10019	25.65

Summary of Mix Produced

To Road	3707.24	Tons
Plant Waste	0.0	Tons
Road Waste	0.0	Tons
To Others	0.0	Tons
Produced	3707.24	Tons

Problem #2

Hydrated Lime

Complete the DOT-33Q form below. What is the Job Mix Formula Tolerance? _____

TANK METHOD

A. Weight of Lime in Tank at Start (Tons) ☐ Tons at Start (at start of project only)	41.23
B. Weight of Lime Added to Tank (Tons)	
C. Weight of Lime in Tank at End (Tons) ☐ Left in Storage (at end of project only)	39.37
D. Weight of Lime Used (A + B - C) (Tons)	
E. Weight of Mix Produced (Tons)	
F. Percent of Lime in Mix (D / E x 100)	

B.

Load #	Invoice #	Tons
2	5552	34.90

Summary of Mix Produced

To Road	3707.24
Plant Waste	0.0
Road Waste	0.0
To Others	0.0
Produced	3707.24

Problem #3

Moisture in the Mix

Complete the calculations below. What is the max % moisture allowed? _____

A.	Container Number:	1
B.	Weight of container and cover (g):	222.3
C.	Weight of container, cover and sample (g):	1723.7
D.	Apparent dry weight (g): (C – B)	
E.	Actual dry weight (g): (J – B)	
F.	Moisture in material (g): (D – E)	
G.	% Moisture in the Mix: (F / E) * 100	

DRYING WEIGH BACK AREA (H)

		Time	Weight (g)
		12:00 PM	1722.1
		2:00 PM	1721.9
		3:00 PM	1721.8
J.	**Weight of material and pan:**		**1721.8**

Percent Moisture in the Mix: ☐

Spec: ☐

Problem #4

RAP Content

Complete the DOT-93 form below. Use the RAP equation sheet found in the Problems Packet. What is the Job Mix Formula Tolerance? _____

WEIGH TICKET ENTRIES

A.	Total of hot mix produced by tickets (tons)	3707.24
B.	Moisture in the mix percentage (most recent one tested)	0.13
C.	Moisture in the mix (tons)	
D.	Total dry amount of hot mix produce for the day (tons)	
E.	Added binder percentage by cutoff (DOT-89)	4.20
F	Total amount of added binder (tons)	
G.	Added lime percentage by cutoff (DOT-33Q)	0.99
H.	Total amount of added lime (tons)	
I.	Total dry Virgin MA and RAP from tickets & cutoffs (tons)	

WEIGH BRIDGE ENTRIES

J.	Weight of Virgin MA from weight bridge totalizer (tons)	2761.1
K.	Percentage moisture in Virgin MA	3.9
L.	Weight of water in in Virgin MA (tons)	
M.	Weight of dry Virgin MA (tons)	
N.	Weight of RAP from weigh bridge totalizer (tons)	830.2
O.	Percent moisture in RAP	0.2
P.	Weight of water in the RAP mixture (tons)	
Q.	Weight of dry RAP from weigh bridge totalizer (tons)	
R.	Total dry Virgin MA and RAP from weigh bridges (tons)	

RAP PERCENTAGES

S.	Percentage of RAP based on weigh bridges	
T.	Percentage of RAP based on weigh tickets	
U.	% difference between scale tickets and weigh bridges	

Problem #5

Draindown

Calculate the draindown percentage on the DOT-91 form below.

Sample ID
File No.

Asphalt Draindown Worksheet

DOT - 91
9-15

PROJECT _____ COUNTY _____ PCN _____

Field # _____ Date Sampled _____ Date Tested _____

Sampled By _____ Tested By _____ Checked By _____

MixType Class S Asphalt Cement _____ Cellulose Fibers _____

			Weight of test sample	1327.4	grams
Weight of container empty	52.3	grams	Weight of container after test	53.1	grams
Draindown		≤ 0.3%	Temperature of test sample	300	°F

Problem #6

DOT-86
Gyratory Worksheet

Complete the DOT-86 for a Q2R Mix.

Use the equation sheet in the Problems Packet.

Mix Temp	275
% binder Pb	5.4
Gsb	2.609
binder Gb	1.035
dust (- #200)	3.70
lime	0.99
dust(-#200) + lime	

	No. of gyrations
N initial	
N design	
N max	

Gse	
Pba	
Pbe	

	Spec. A (Ndes)		Spec. B (Ndes)	
	@ N ini	@ N des	@ N ini	@ N des
a) Height, mm	124.2	115.7	124.6	115.9
b) Weight in air		4738.1		4746.5
c) Weight in water		2724.9		2729.9
d) SSD Weight		4741.8		4749.6
e) Gmb (measured) b / (d - c)				
f) Gmb (calculated)				

	Gmm #1	Gmm #2
Weight of sample in air	1505.3	1523.9
Weight of canister + H_2O	1275.3	1275.3
Weight of canister + H_2O + sample	2166.6	2177.5
Temperature of water	24.4	24.4
H_2O correction factor	1.0001	1.0001
Rice SpGr (Gmm)		

Average Max SpGr (Gmm)

	N initial	N design
Average Gmb		
% of Rice SpGr (Gmm)		

% Air Voids (Va)		**% VMA**		**% VFA**		**Dust to Binder Ratio**	
Specs:							

Problem #7

Core Dryback

Complete the DOT-42-Q form below.

Theoretical Maximum Specific Gravity

Sublot No.	1	2	3	4	5				
Max. Sp. Gr.	2.447	2.452	2.452	2.450	2.441				

Lot Average Maximum Specific Gravity (Standard) _____

In-Place Density Measurement

Percent of Standard = [(Core Bulk Specific Gravity / Lot Average Maximum Specific Gravity)] x 100

Core Sublot No.	Height	Rand Nbr.	Cumulative Tonnage	Station for Core	Rand Nbr	Paving Width	Distance from C/L		Actual Dry Weight	Weight in Water	SSD Weight	Reheat Correction Factor	Core Bulk Specific Gravity	Percent of Standard	Average Percent Standard
1 A	2.00	.61	305	165+52	.28	11	3.1	LT	1340.3	757.7	1351.7		2.256		
1 B	2.25	.99	995	123+71	.65	11	7.2	LT	1430.2	808.0	1440.2		2.262		
2 A	2.13	.06	1,030	121+59	.17	11	1.9	LT	1308.2	739.8	1314.7		2.276		
2 B	2.50	.65	1,825	73+42	.18	11	2.0	LT	1530.2	860.2	1541.3		2.247		
3 A	2.13	.01	2,005	62+51	.82	11	9.0	LT	1312.5	739.0	1321.8		2.252		
3 B	2.25	.32	2,660	22+82	.69	11	7.6	LT	1386.8	780.6	1397.0		2.250		
4 A	2.38	.00	3,000	2+22	.26	11	2.9	LT	1504.5	851.9	1510.3		2.285		
4 B	1.75	.84	3,920	143+72	.90	11	9.9	RT	1197.8	679.8	1202.2		2.293		
5 A	2.38	.36	4,180	127+23	.10	11	1.1	RT	1441.7	802.7	1449.0		2.231		
5 B	2.25	.07	4,535	104+71	.59	11	6.5	RT	1463.7	832.4	1467.9		2.303		

Percent Density: _____