

# **CMT ENGINEERING** **LABORATORIES**

Geotechnical • Materials Testing • Special Inspections • Chemical Analysis

## **MARSHALL METHOD**

### **BITUMINOUS MIX DESIGN**

**ASTM D-1559 AND ASPHALT INSTITUTE MS-2**

**Prepared for: Asphalt Materials Inc**

**Mix Design: 1/2" Custom PG 58-28**

**non apwa spec 35% Rap**

**Date Prepared: April 29, 2019**

**Blows: 50**



<b>Bulk Unit Weight</b>	<b>Max Unit Weight (Voidless / Rice)</b>
<b>143.9</b>	<b>149.2</b>

## MARSHALL METHOD BITUMINOUS MIX DESIGN ASTM D-1559 AND ASPHALT INSTITUTE MS-2

Prepared for: Asphalt Materials

Lab #: 751340

Project: Various Projects

Date: April 29, 2019

Product: Custom 1/2 35% Rap

Max Size: 1/2

Project #: 5648

Gentlemen:

CMT Engineering Labs performed an Asphalt Mix Design in accordance with ASTM D-1559 and Asphalt Institute MS-2, to determine the optimum binder content for the Job Mix Target listed below.

The aggregate physical properties were determined and are listed on page 2, the asphalt physical properties were measured and are provided on page 3.

### RECOMMENDED DESIGN CRITERIA

Stability:	3607	Recommended Oil Content:	5.58
Flow:	11.7	Virgin Oil Content:	3.79
Air Voids:	3.5	Lottman (TSR):	95.5%
VMA:	13.8	Binder Supplier:	Sinclair
Anti-Strip:	None Required	Virgin Binder Grade: PG	58 -28
Voids Filled VFA:	74.6	No. of Blows:	50
Dust Asphalt Ratio:	1.51	Max. Unit Weight (Rice):	149.2
Effective Asphalt Content:	4.38	Bulk Unit Weight:	143.9

### Job Mix Formula

(inch)	(mm)	Percent Passing	0.50
1	25	100	
3/4"	19	100	
1/2"	12.5	100	100 - 100
3/8"	9.5	93	
#4	4.75	60	60 - 80
#8	2.36	40	
#16	1.18	28	28 - 42
#30	0.6	21	
#50	0.3	16	11 - 23
#100	0.15	11	
#200	0.075	6.6	3 - 7

**Aggregate Source Proportions**

Aggregate Source	Product Name	Proportions (%)
P.O.M	3/4	0
P.O.M	1/2	22.5
P.O.M	1/4	21
P.O.M	Sand	21.5
0		0
COURSE RAP	RAP 1	25
FINE RAP	RAP 2	10
None	Lime	0
Total		100

**Aggregate Blend Physical Properties**

Test Method	Results	Specification
MgSo4 Soundness (coarse) ASTM C-88	0.43	16 % Max.
MgSo4 Soundness (fine) ASTM C-88	2.40	16 % Max.
Dry Rodded Unit Weight ASTM C29	119.1	75 Min.
Fracture Face Count - Two Face's	95.8	50% Min.
Los Angeles Wear ASTM C-131	22	40% Max.
Sand Equivelent D-2419	64	45 MIN
Clay Lumps and Friable Particles C-142	0.0	2 max
Flat or Elongated Particles D-4791	1.0	20%Max
Plastic Index ASTM D-4318	Non-Plastic	6 Max.
Liquid Limit ASTM D-4316	Non-Plastic	25 Max

**Specific Gravity of Aggregates**

Product Name	Bulk Specific Gravities	Apparent Specific Gravities	Water Absorption	Proportion
3/4	2.651	2.713	0.90	0
1/2	2.491	2.591	1.60	22.5
1/4	2.489	2.594	1.60	21
Sand	2.604	2.625	0.30	21.5
	0.000	0.000	0.00	0
RAP 1	2.567	2.615	1.10	25
RAP 2	2.498	2.498	1.9	10
None	2.626	2.626	5.07	0
Blend Totals	2.534	2.608	1.23	100

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**Aggregate Products**

	3/4	1/2	1/4	Sand	0	RAP 1	RAP 2	Lime	Bag House Offset	JMF	Min	Max
<b>Percent Selected</b>	<b>0.0</b>	<b>22.5</b>	<b>21.0</b>	<b>21.5</b>	<b>0.0</b>	<b>25.0</b>	<b>10.0</b>	<b>0.0</b>			0.50	
I	100	100	100	100	0	100	100	100	0	100		
3/4"	100	100	100	100	0	100	100	100	0	100	100	100
1/2"	47	100	100	100	0	100	100	100	0	100		
3/8"	7	70	100	100	0	98	100	100	0	93	60	80
#4	3	3	46	99	0	79	88	100	0	60		
#8	2	2	6	83	0	59	62	100	0	40	28	42
#16	2	2	4	52	0	44	45	100	0	28		
#30	2	2	3	38	0	33	35	100	0	21	11	23
#50	1	2	3	29	0	24	26	100	0	16		
#100	1	2	3	21	0	17	17	99	0	11	3	7
#200	1.2	1.5	2.3	11.0	0.0	10.1	8.9	98.0	0.0	6.6	#REF!	#REF!

**Summary of Trial Mixture Bin Ratios**

Trial Blend #	3/4	1/2	1/4	Sand	0	RAP 1	RAP 2	Lime	Total
1	0	22.5	21	21.5	0	25	10	0	100
2	0	17	26	22	0	25	10	0	100
3	0	15	26	24	0	25	10	0	100
4	0	14	29	22	0	25	10	0	100
5	0	0	43	22	0	25	10	0	100

**Summary of Trial Mixture Propertys**

Trial #	Asphalt Content	Bulk Specific Gravity	Bulk Unit Weight	Stability	Flow	Air Voids	VMA	VFA	Max Specific Gravity	Max Unit Wt. (Rice)
1	5.25	2.249	140.0	2756		6.68	15.89	57.98	2.410	150.0
2	5.25	2.277	141.7	2568		5.53	14.88	62.81	2.410	150.0
3	5.25	2.264	140.9	2797		6.06	15.43	60.71	2.410	150.0
4	5.25	2.245	139.7	3053		6.84	16.06	57.38	2.410	150.0
5	5.00	2.265	141.0			6.38	15.09			2.419

**Summary of Paving Mixture Properties**

Asphalt Content	Bulk Specific Gravity	Bulk Unit Weight	Stability	Flow	Air Voids	VMA	VFA	Max Specific Gravity	Max Unit Wt. (Rice)
5.25	2.285	142.2	3169	10	5.2	14.6	64.57	2.409	149.9
5.50	2.305	143.5	3646	11	4.0	14.0	71.82	2.400	149.4
5.75	2.328	144.9	3524	12	2.5	13.4	80.40	2.389	148.7
6.00	2.329	145.0	3043	14	2.2	13.6	83.55	2.382	148.3

**Summary of Paving Mixture Properties @ Recommended Oil Content**

Asphalt Content	Bulk Specific Gravity	Bulk Unit Weight	Stability	Flow	Air Voids	VMA	VFA	Max Specific Gravity	Max Unit Wt. (Rice)
5.58	2.313	143.9	3607	12	3.5	13.8	74.6	2.396	149.2

**RAP, M323 Properties**

Asphalt contribution from RAP	1.79
Total Binder Recommendation	5.58
Percent Binder from RAP	32.03
Max. Allowable Binder Contribution M323	24.10
AASHTO M323 Compliant	No

**Paving Mixture Properties**

Mixing Temp	305
Compaction Temp	271
Dust to Asphalt Ratio	1.51
Hamburg Loaded Wheel Tes	N/A

**Asphalt Water Susceptibility**

Test Specimen	Lottman AASHTO T-283-89:			Immersion Compression ASTM C-1074, 1075	
	Tensile Strength (PSI)	Retained Strength %	Stripping Index	Dry Strength (PSI)	Retained Strength %
Dry Controls	126.2				
Wet Controls	120.6	95.5%			
1/4% Liquid Anti-Strip					
1% Lime					
1.5% Lime					

*Doug Watson*

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Douglas Watson

# AASHTO M 323

Customer: Asphalt Materials

Project: Various Projects

Custom

Date of Analysis: 3/15/18

## BLENDING WITH A KNOWN VIRGIN BINDER (M323 - X1.4.)

### Known Parameters

- |   |    |            |
|---|----|------------|
| 1. Specified Final Blended Binder Grade | PG | 58 -28     |
| 2. Virgin Asphalt Binder Grade          | PG | 58 -28     |
| 3. Recovered RAP Binder Properties      | PG | 89.2 -17.5 |

$T_{\text{Virgin High}}$  = Critical High Temp of Virgin Asphalt Binder 56

$T_{\text{Virgin Inter}}$  = Critical Inter Temp of Virgin Asphalt Binder 19

$T_{\text{Virgin Low}}$  = Critical Low Temp of Virgin Asphalt Binder -29

$T_{\text{Spec High}}$  = Critical High Temp of Blended Asphalt Binder 64

$T_{\text{Spec Inter}}$  = Critical Inter Temp of Blended Asphalt Binder 25

$T_{\text{Spec Low}}$  = Critical Low Temp of Blended Asphalt Binder -22

$T_{\text{RAP High}}$  = Critical High Temp of RAP Binder 89.2

$T_{\text{RAP Inter}}$  = Critical Inter Temp of RAP Binder 29.7

$T_{\text{RAP Low}}$  = Critical Low Temp of RAP Binder -17.5

### Maximum Allowable Binder Contribution %

% RAP<sub>High</sub> = **24.10** % Binder

% RAP<sub>Inter</sub> = **56.07**

% RAP<sub>Low</sub> = **60.87**

Max % Binder **24.10**

Lab#: 751340



