

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" Asphalt PG 58-28

RAP: 25 %

Date Prepared: February 24, 2020

Blows: 50



Bulk Unit Weight	Max Unit Weight (Voidless / Rice)
142.4	147.7

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

Prepared for: Asphalt Materials

Lab #: 817194

Project: Various Projects

Date: February 24, 2020

Product: 2017 APWA DM-1/2" 25.0% 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:	3088	Recommended Oil Content:	5.75
Flow:	12.0	Virgin Oil Content:	4.46
Air Voids:	3.6	Lottman (TSR):	91.0%
VMA:	15.0	Binder Supplier:	Sinclair
Anti-Strip:		Virgin Binder Grade: PG	58 -28
Voids Filled VFA:	76.1	Final Binder Grade: PG	64 -22
Dust Asphalt Ratio:	1.37	No. of Blows:	50
Effective Asphalt Content:	5.15	Max. Unit Weight (Rice):	147.7
		Bulk Unit Weight:	142.4

Job Mix Formula

(inch)	(mm)	Percent Passing	DM-1/2"
1	25	100	
3/4"	19	100	
1/2"	12.5	100	100 - 100
3/8"	9.5	95	
#4	4.75	70	60 - 80
#8	2.36	51	
#16	1.18	36	28 - 42
#30	0.6	28	
#50	0.3	23	11 - 23
#100	0.15	16	
#200	0.075	7.0	3 - 7

Aggregate Source Proportions

Aggregate Source	Product Name	Proportions (%)
Parleys Pit	3/4"	0
Point of Mountain	1/2"	18
Point of Mountain	1/4"	11
Point of Mountain	Sand	46
Point of Mountain	0.00	0
WJ Pit	Course Rap	25
WJ Pit	Fine Rap	0
None	Lime	0
Total		100

Aggregate Blend Physical Properties

Test Method	Results	Specification
MgSo4 Soundness (coarse) ASTM C-88	0.50	16 % Max.
MgSo4 Soundness (fine) ASTM C-88	1.50	16 % Max.
Dry Rodded Unit Weight ASTM C29	120.1	75 Min.
Fracture Face Count - Two Face's	91.8	50% Min.
Los Angeles Wear ASTM C-131	22	40% Max.
Sand Equivalent ASTM D-2419	81	45 MIN
Clay Lumps and Friable Particles ASTM C-142	0.0	2 max
Flat or Elongated Particles ASTM D-4791	0.0	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"	2.671	2.717	0.63	0
1/2"	2.477	2.592	1.80	18
1/4"	2.474	2.573	1.59	11
Sand	2.559	2.657	1.58	46
0	0.000	0.000	0.00	0
Course Rap	2.623	2.715	1.29	25
Fine Rap	0	0	0	0
None	0	0	0	0
Blend Totals	2.550	2.650	1.55	100

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)
5.50	2.280	141.9	3081	10	4.3	15.5	72.45	2.382	148.3
5.75	2.288	142.4	3088	12	3.6	15.4	76.77	2.373	147.7
6.00	2.306	143.5	2955	14	2.5	15.0	83.46	2.365	147.2
6.25	2.320	144.4	2918	16	1.5	14.7	89.70	2.356	146.7

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)
5.75	2.288	142.4	3088	12	3.6	15.0	76.1	2.373	147.7

RAP, M323 Properties

Asphalt contribution from RAP	1.29
Total Binder Recommendation	5.75
Percent Binder from RAP	22.39
Max. Allowable Binder Contribution M323	25.08
AASHTO M323 Compliant	Yes

Paving Mixture Properties

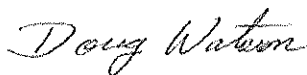
Mixing Temp	307
Compaction Temp	273
Dust to Asphalt Ratio	1.37
Hamburg Loaded Wheel Tes	N/A

Asphalt Water Susceptibility

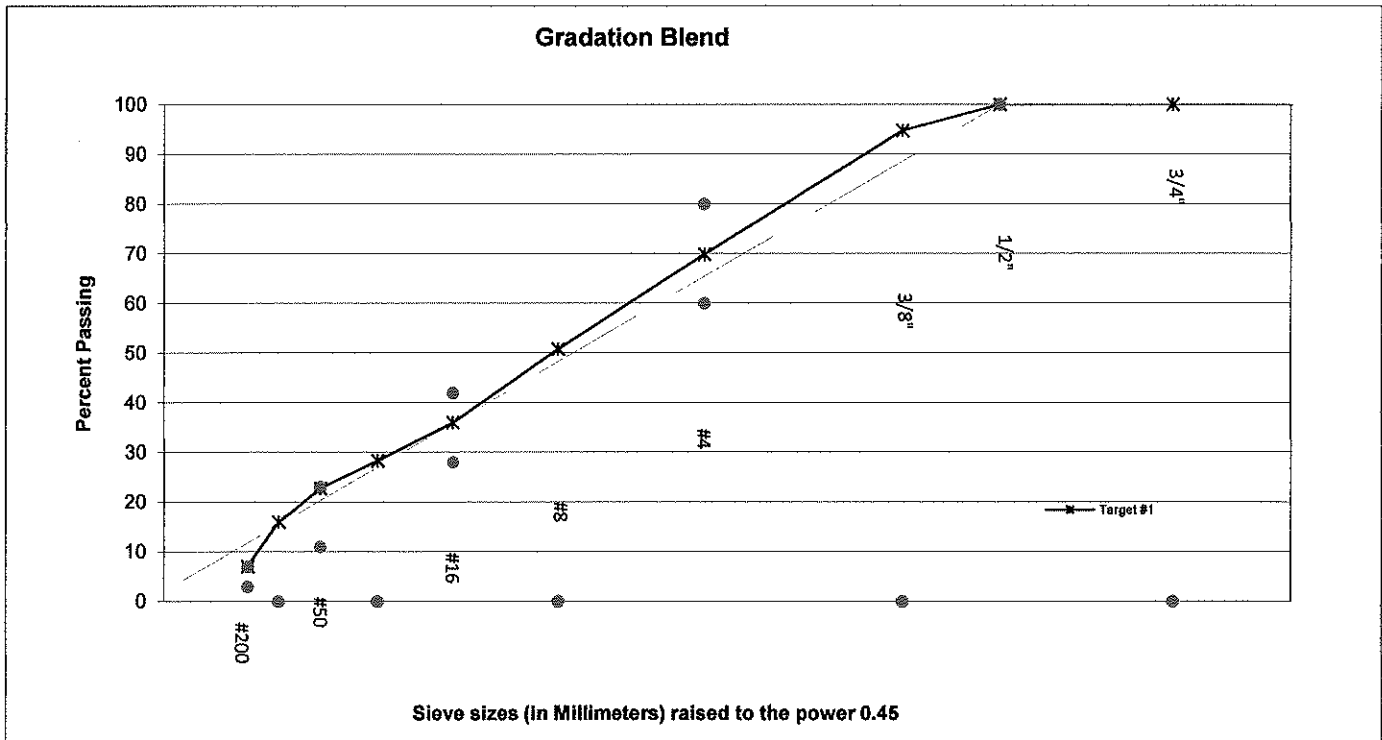
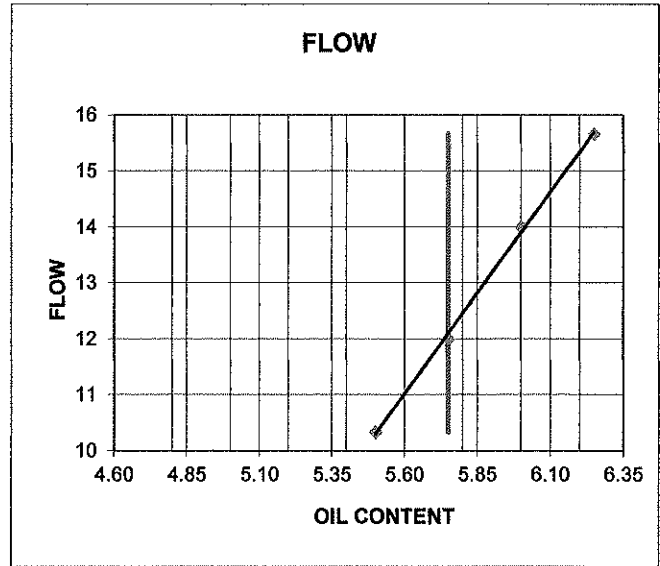
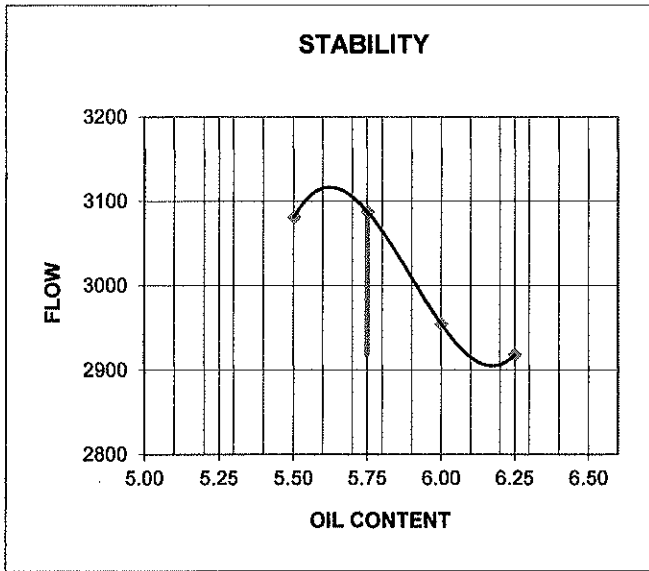
Lottman AASHTO T-283-89:

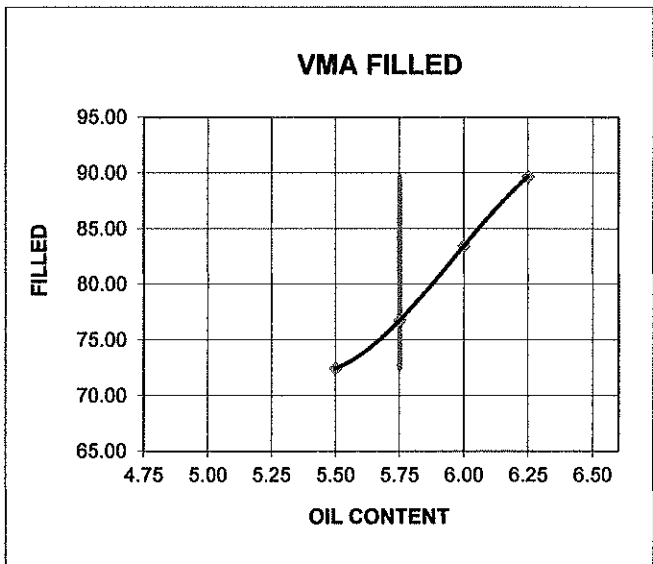
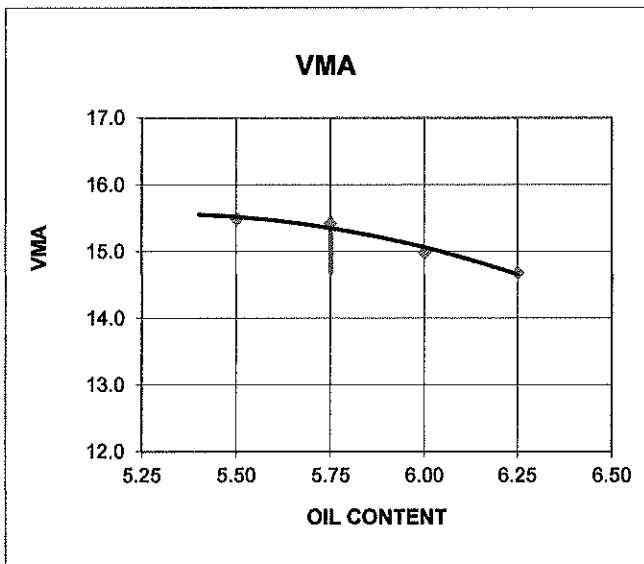
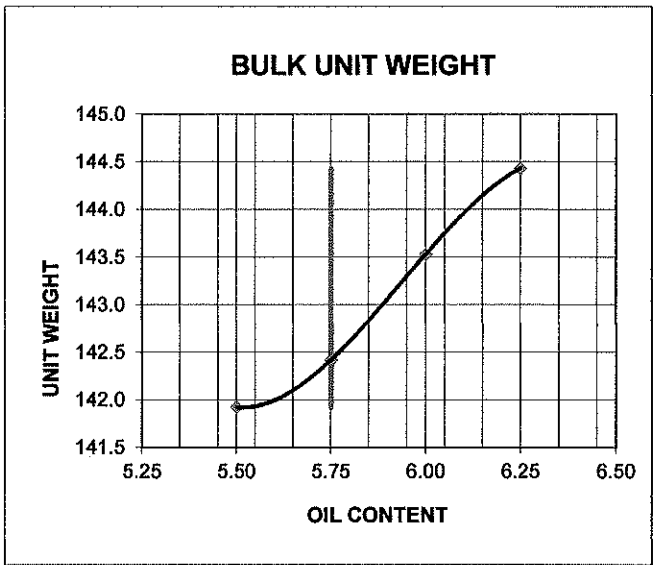
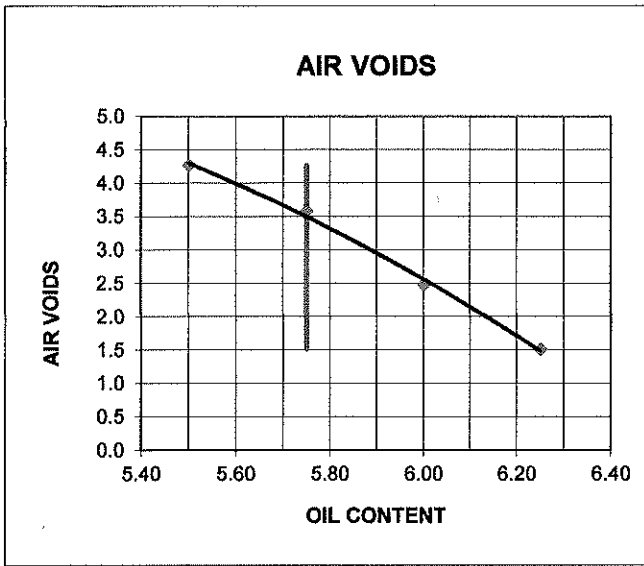
Immersion Compression
ASTM C-1074, 1075

Test Specimen	Tensile Strength (PSI)	Retained Strength %	Stripping Index	Dry Strength (PSI)	Retained Strength %
Dry Controls	120.2				
Wet Controls	109.5	91.1%			
1/4% Liquid Anti-Strip					
1% Lime					
1.5% Lime					



 Douglas Watson





AASHTO M 323

Customer: Asphalt Materials
Project: Various Projects

2017 APWA

Date of Analysis: 2/12/20

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

Known Parameters

1. Specified Final Blended Binder Grade	PG	64	-22
2. Virgin Asphalt Binder Grade	PG	58	-28
3. Recovered RAP Binder Properties	PG	87.9	-21.2

$T_{Virgin\ High}$ = Critical High Temp of Virgin Asphalt Binder		56.0	Virgin Binder True Grade)
$T_{Virgin\ Inter}$ = Critical Inter Temp of Virgin Asphalt Binder		19	
$T_{Virgin\ Low}$ = Critical Low Temp of Virgin Asphalt Binder		-29.0	
$T_{Spec\ High}$ = Critical High Temp of Blended Asphalt Binder		64	Spec Binder
$T_{Spec\ Inter}$ = Critical Inter Temp of Blended Asphalt Binder		25	
$T_{Spec\ Low}$ = Critical Low Temp of Blended Asphalt Binder		-22	
$T_{RAP\ High}$ = Critical High Temp of RAP Binder		87.9	RAP Binder
$T_{RAP\ Inter}$ = Critical Inter Temp of RAP Binder		28.8	
$T_{RAP\ Low}$ = Critical Low Temp of RAP Binder		-21.2	

Maximum Allowable RAP Contribution %

% RAP _{High} =	25.08	% Binder
% RAP _{Inter} =	61.22	
% RAP _{Low} =	89.74	

Max % Binder **25.08**

Lab#: 817194