

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: 23 %

Date Prepared: March 15, 2021

Blows: 50



Bulk Unit Weight	Max Unit Weight (Voidless / Rice)
142.3	147.5

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

Prepared for: Asphalt Materials

Lab #: 883048

Project: Various Projects

Date: March 15, 2021

Product: 2017 APWA DM-1/2" 23% 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:	3245	Recommended Oil Content:	5.62
Flow:	14.3	Virgin Oil Content:	4.63
Air Voids:	3.5	Lottman (TSR):	90.2%
VMA:	15.0	Binder Supplier:	Sinclair
Anti-Strip:		Virgin Binder Grade: PG	58 -28
Voids Filled VFA:	76.5	Final Binder Grade: PG	64 -22
Dust Asphalt Ratio:	1.35	No. of Blows:	50
Effective Asphalt Content:	4.98	Max. Unit Weight (Rice):	147.5
		Bulk Unit Weight:	142.3

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	97	
#4	4.75	71	60 - 80
#8	2.36	48	
#16	1.18	33	28 - 42
#30	0.6	26	
#50	0.3	20	11 - 23
#100	0.15	15	
#200	0.075	6.7	3 - 7

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Lab#: 883048

Blend # 1

Aggregate Source Proportions

Aggregate Source	Product Name	Proportions (%)
WJP	3/4"	0
POM	1/2"	10
POM	1/4"	24
POM	Sand	43
0	0.00	0
WJP	CA Rap	23
WJP	FR	0
None	Lime	0
Total		100

Aggregate Blend Physical Properties

Test Method	Results	Specification
MgSo4 Soundness (coarse) ASTM C-88	1.90	16 % Max.
MgSo4 Soundness (fine) ASTM C-88	2.70	16 % Max.
Dry Rodded Unit Weight ASTM C29	105.3	75 Min.
Fracture Face Count - Two Face's	90.8	50% Min.
Los Angeles Wear ASTM C-131	20	40% Max.
Sand Equivelent ASTM D-2419	72	45 MIN
Clay Lumps and Friable Particles ASTM C-142	0.0	2 max
Flat or Elongated Particles ASTM D-4791	10.6	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	2.702	0.70	0
1/2"	2.464	2.578	1.79	10
1/4"	2.474	2.599	2.30	24
Sand	2.544	2.615	1.08	43
0	0.000	0.000	0.00	0
CA Rap	2.628	2.707	1.11	23
FR	0	0	0	0
None	0	0	0	0
Blend Totals	2.537	2.628	1.45	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)
5.20	2.251	140.1	3313	10	5.6	15.9	64.96	2.384	148.4
5.50	2.274	141.6	3256	13	4.2	15.3	72.60	2.374	147.8
5.80	2.303	143.3	3428	16	2.6	14.5	82.34	2.363	147.1
6.10	2.317	144.2	2677	18	1.5	14.2	89.25	2.353	146.5

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)
5.62	2.286	142.3	3245	14	3.5	15.0	76.5	2.370	147.5

RAP, M323 Properties

Asphalt contribution from RAP	0.99
Total Binder Recommendation	5.62
Percent Binder from RAP	17.60
Max. Allowable Binder Contribution M323	20.00
AASHTO M323 Compliant	Yes

Paving Mixture Properties

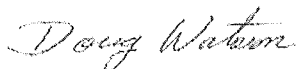
Mixing Temp	300
Compaction Temp	269
Dust to Asphalt Ratio	1.35
Hamburg Loaded Wheel Test	N/A

Asphalt Water Susceptibility

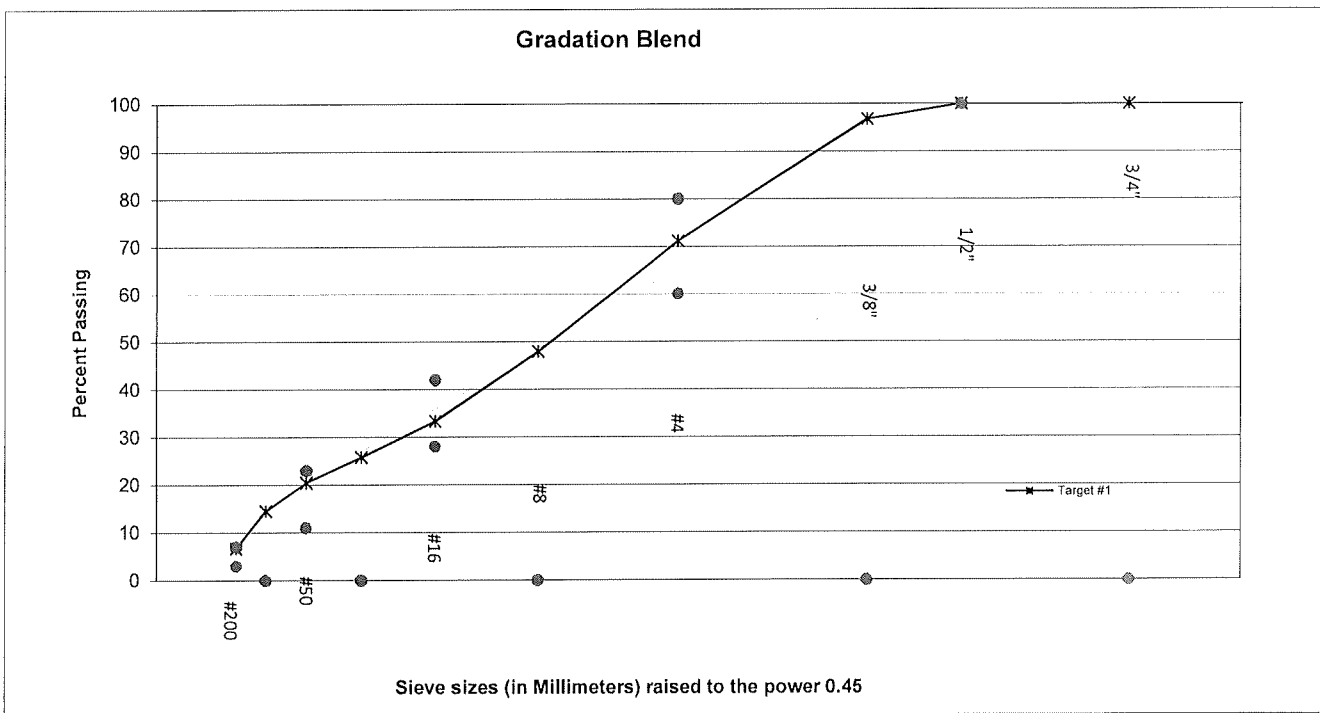
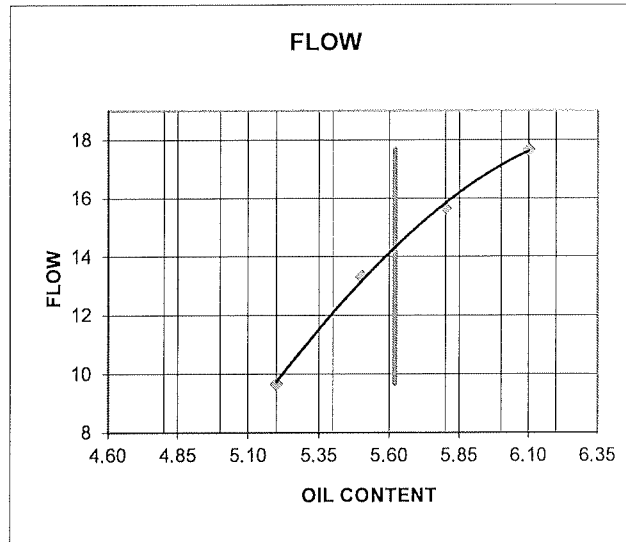
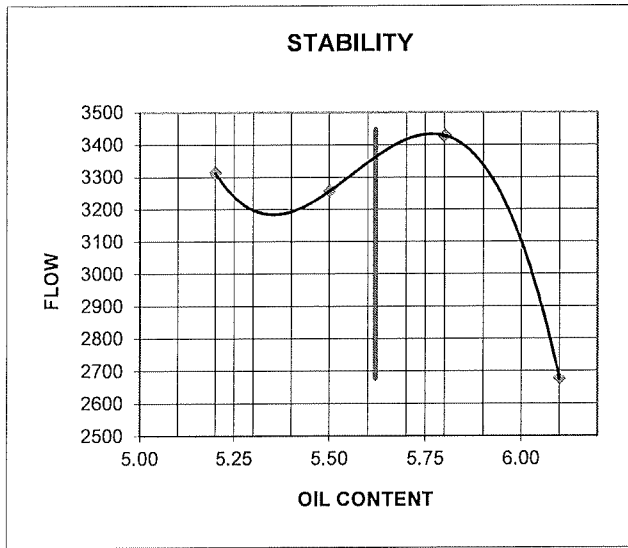
Lottman AASHTO T-283-89:

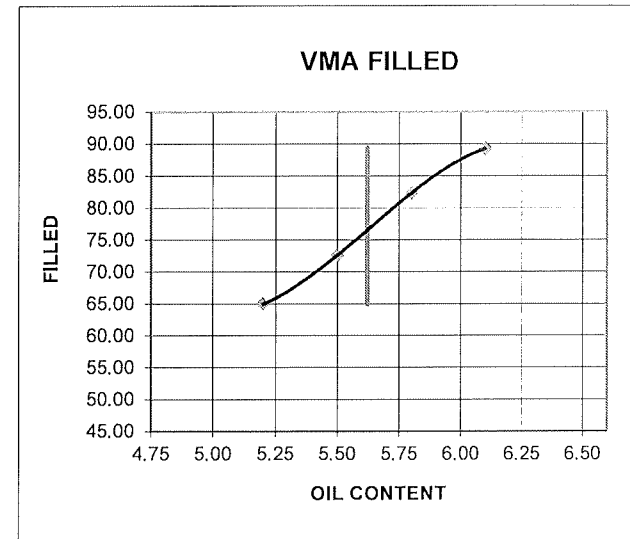
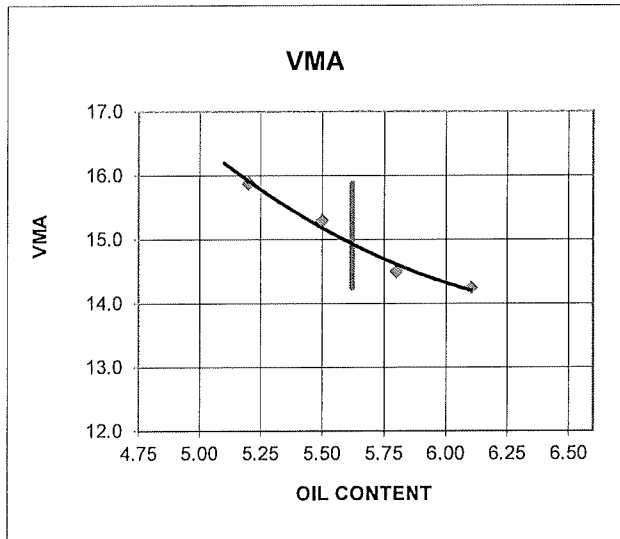
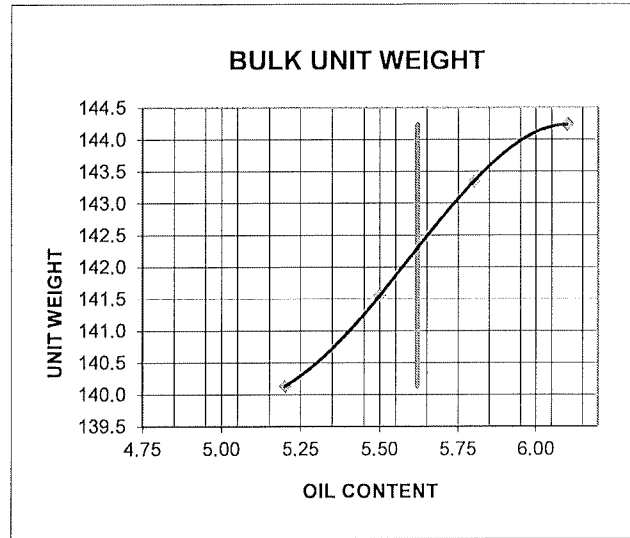
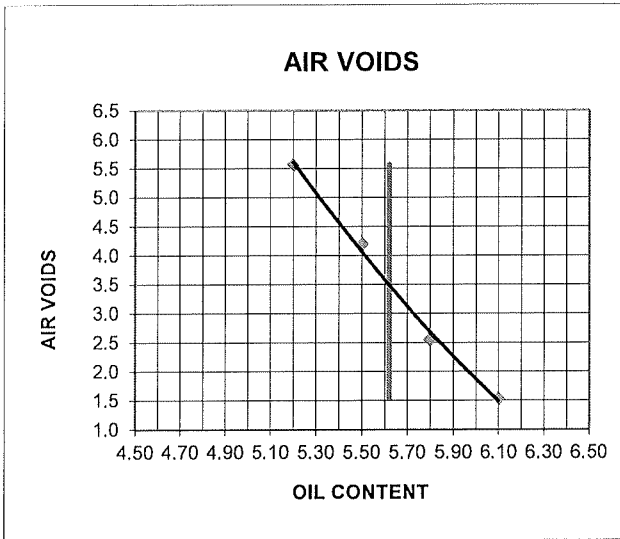
Immersion Compression
ASTM C-1074, 1075

Test Specimen	Tensile Strength (PSI)	Retained Strength %	Stripping Index	Dry Strength (PSI)	Retained Strength %
Dry Controls	182.7				
Wet Controls	164.8	90.2%			
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: 12/17/20

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	88.0	-16

$T_{Virgin\ High}$ = Critical High Temp of Virgin Asphalt Binder		58
$T_{Virgin\ Inter}$ = Critical Inter Temp of Virgin Asphalt Binder		19
$T_{Virgin\ Low}$ = Critical Low Temp of Virgin Asphalt Binder		-28
$T_{Spec\ High}$ = Critical High Temp of Blended Asphalt Binder		64
$T_{Spec\ Inter}$ = 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		88
$T_{RAP\ Inter}$ = Critical Inter Temp of RAP Binder		29.7
$T_{RAP\ Low}$ = Critical Low Temp of RAP Binder		-16

Virgin Binder
Spec Binder
RAP Binder

Maximum Allowable RAP Contribution %

% RAP _{High} =	20.00	% Binder
% RAP _{Inter} =	56.07	
% RAP _{Low} =	50.00	

Max % Binder **20.00**

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