



Superpave Mix Design

Attn: Mr. Lars Colberg	Date: January 25, 2019
Client: Sunroc Corporation 4015 S. Banner Street Boise, Idaho 83709	*Revised Date: February 12, 2020
Project: Commercial Asphalt Mix Designs	Job Mix Formula No.: A518-1042
Project No.: NA	Mix Type: 1/2" SP3
Key No.: NA	Design Specification: ISPWC
	Design ESAL's: 1 < 10
	Specified PG Binder Grade: PG 58-28
	Source: Ad-182c (Corral)
	Prepared By: D. Kilmer - 22046

Material used for developing this design was sampled by Sunroc Corporation (Sunroc) on December 28, 2018. Material was sampled from the Corral Pit (Ad-182c), located in Ada County, Idaho for use in developing a 1/2-inch SP3 PG 58-28, 1 < 10 million design ESALs Superpave hot mix asphalt design. The following job mix formula (JMF) was developed according to the 2017 Idaho Standards For Public Works Construction specifications. Sunroc supplied ALLWEST TESTING & ENGINEERING (ALLWEST) with stockpile average gradations and anticipated blend percentages. The specified PG 58-28 binder and Typical Temperature-Viscosity Graph was supplied by Western States Asphalt. Evotherm M1 anti-strip/warm mix additive was supplied by Ingevity. ALLWEST separated the aggregate material provided by appropriate sieve sizes. The material was combined to the achieved target gradation values as shown on this JMF.

Many factors during production (such as stockpile management, asphalt content, and weather conditions) are beyond the control of ALLWEST and can directly influence the characteristics of the mix. Slight changes to this mix design may be needed during production to achieve the desired JMF mix properties. ALLWEST can assist with changes to the JMF to meet specifications, if necessary. Variations in source material may prevent the JMF from achieving the desired mix properties. Notable variations may require laboratory adjustment of the JMF, and in extreme cases development of a new JMF may be necessary.

Additional testing of aggregate material was performed in order to develop this JMF in general accordance with updated AASHTO and ASTM standards. JMF tests necessary to establish this design were as follows:

	Tested By	WAQTC #	ASTM	AASHTO
Washed Sieve Analysis	J. Calkins	23528	C-117	T-11
Coarse & Fine Sieve Analysis	J. Calkins	23528	C-136	T-27
Asphalt Content by Ignition Method	J. Calkins	23528	D-6307	T-308
Mechanical Analysis of Extracted Aggregate	J. Calkins	23528	D-5444	T-30
Sand Equivalent	J. Calkins	23528	D-2419	T-176
Specific Gravity of Fine Aggregate	D. Kilmer	22046	IT-144	
Specific Gravity of Coarse Aggregate	D. Kilmer	22046	C-127	T-85
Fracture Face Count	J. Calkins	23528	D-5821	TP-61
Flat & Elongated Pieces	D. Kilmer	22046	D-4791	--
Un-compacted Voids in Fine Aggregate	J. Calkins	23528	C-1252	T-304
Superpave Design Procedure	D. Kilmer	22046	--	R-35
Theoretical Maximum Density	J. Calkins	23528	D-2041	T-209
Bulk Specific Gravity of Compacted Samples	J. Calkins	23528	D-2726	T-166
Percent Voids	D. Kilmer	22046	D-3203	T-269
Resistance to Moisture Procedure	D. Kilmer	22046	D-1075	T-167

CONCLUSIONS

Based on the results of the laboratory testing performed by ALLWEST and our understanding of the specifications provided, the JMF provided in this report appears to meet the requirements for the specified project mix design. It should be recognized that the mix properties can be affected during production by many variables that are beyond the control of ALLWEST.

LIMITATIONS

This report has been prepared to assist Sunroc with the design and construction of the proposed 1/2-inch SP3 Superpave plant mix asphalt pavement. This report is for the exclusive use of the addressee for use in design and construction for future projects. In the absence of our written approval, we make no representations and assume no responsibility to other parties regarding this report.

The data and recommendations provided represent the results of tests performed on specific samples provided by the client and have not been evaluated with respect to any engineering criteria or construction methods. Our professional services were performed in accordance with generally accepted materials testing principles and practices for similar projects in our area at the time of this report. This acknowledgement is in lieu of all warranties either expressed or implied. The data furnished in this mix design is prepared for Sunroc and shall be used as a design aid in producing this 1/2-inch SP3 Superpave hot mix asphalt. No warranties, express or implied shall be made. The information in this report only represents the test results generated by ALLWEST.

Respectfully submitted,

ALLWEST Testing and Engineering, Inc.


Daniel Kilmer #22046
Transportation Services Manager


Adrian Mascorro, P.E.
Mix Design Review Engineer



ATTACHED: Design Specifications / JMF
Mix Design Aggregate Blend Data Sheet
Power 0.45 Curve
Mix Design Report Charts
Typical Temperature-Viscosity Graph
RAP Crusher Control Summary
Trial Verification

*Revision: At the request of Ada County Highway District, verification points were blended at the original mix design targets (for the mix design performed in 2019) to confirm all mix properties are within the required specifications for use in future commercial projects. The volumetric properties were confirmed, as seen on the attached Trial Verification results.

Design Specifications: Blend 1 / 75 Gyration @ N Design PG 58-28

Gyratory Compactor:	Model # Serial #	AFG2AS 8436	Job Mix Formula	Spec
1	Percent Asphalt by Weight of Total Mix		5.3	--
2	Percent Asphalt by Weight of Aggregate		5.6	--
3	Virgin Asphalt by Weight of Mix		3.73	--
4	Virgin Asphalt by Weight of Aggregate		3.93	--
5	Percent Air Voids (Pa)		4.0	4.0
6	Voids in Mineral Aggregate (VMA)		14.7	14 min
7	Compacted Unit Weight Gmb, pcf	2.315	144.1	--
8	Theoretical Maximum Density Gmm, pcf	2.412	150.1	--
9	Percent Effective Asphalt Content (Pbe)		4.75	--
10	Percent Absorbed Asphalt (Pba)		0.57	--
11	Specific Gravity of Binder (Gb)		1.029	--
12	Percent Gmm @ N Initial (7 Gyration)		88.3	≤ 89.0
13	Percent Gmm @ N Design (75 Gyration)		96.0	96.0
14	Percent Gmm @ N Max (115 Gyration)		97.6	≤ 98.0
15	Dust to Asphalt Ratio (DP)		1.2	0.6-1.2
16	Percent Passing #200 Sieve		5.5	2.0-10.0
17	Voids Filled w/ Asphalt (VFA)		73	65-75
18	Laboratory Mixing Temperature for Design (°F)		300	296-303
19	Laboratory Compaction Temperature for Design (°F)		280	275-283
20	Laboratory Sample Weight for Volumetric Testing (g)		4640	--
21	Ignition Oven (NCAT) Correction Factor @ 538 °F		0.29	--
22	*Los Angeles Abrasion (LAR) (%)		25	30 max
23	*Idaho Degradation Δ % -200		3.5	5.0 max
24	Sand Equivalent		66	40 min
25	*Fracture Face Count (%)		100/97	75/60
26	Fine Aggregate Angularity (%)		47.2	40 min
27	*Flat and Elongated Particles in Coarse Aggregates (%)		0.6	10 max
Recycled Asphalt Pavement (RAP) Properties				
28	Percentage of Asphalt in RAP (Wt. of Mix)		5.79	--
29	Percentage of RAP by Total Weight of Aggregate		27	--
30	Percent of RAP Binder by Weight of Total Binder		30	30 max
31	RAP Contribution by Mix		1.56	--
32	RAP Contribution by Aggregate		1.66	--
33	RAP NCAT Correction Factor		0.38	--

*Composite blend including RAP



Stockpile Gradation / Blend Percentages
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Source	Ad-182c					Combined Gradation	Specs.
	Sieve Sizes	B-Pile	C-Pile	RAP			
Blend Ratio, %		24	49	27		100%	
1" (25mm)		100	100	100		100	
3/4" (19mm)		100	100	100		100	100
1/2" (12.5mm)		92	100	96		97	90-100
3/8" (9.5mm)		50	100	90		85	90 max
No. 4 (4.75mm)		3	80	69		59	
No. 8 (2.36mm)		1	58	54		43	28-58
No. 16 (1.18mm)		1	41	43		32	
No. 30 (600um)		1	28	32		23	
No. 50 (300um)		1	19	20		15	
No. 100 (150um)		1	11	13		9	
No. 200 (75um)		0.7	7.1	8.5		*5.5	2.0-10.0

*The final blend was adjusted to simulate a reduction of 0.4% minus 200 material through the mitigation process at the hot plant.

N-Cat Aggregate Correction Factors

Sieve Sizes	Target Gradation	N-Cat Ave.	N-Cat Ave. Corr.
1" (25mm)	100	100	--
3/4" (19mm)	100	100	--
1/2" (12.5mm)	97	97	--
3/8" (9.5mm)	85	85	--
No. 4 (4.75mm)	59	59	--
No. 8 (2.36mm)	43	44	--
No. 16 (1.18mm)	32	32	--
No. 30 (600um)	23	23	--
No. 50 (300um)	15	15	--
No. 100 (150um)	9	9	--
No. 200 (75um)	*5.5	5.8	--

Specific Gravity & Absorption
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	+4	-4	RAP	Avg.
Bulk Dry (Gsb)	2.555	2.587	2.568	2.571
SSD	2.595	2.603		
Apparent	2.661	2.630		
% Absorption	1.6	0.6		
Effective (Gse)	2.608			

Stripping Evaluation (Immersion-Compression)

 Type of Stripping Agent: MORLIFE 5000

 Specimen Weight (g): 1,860

% Anti-Strip	% Voids	Dry Strength, psi	Wet Strength, psi	Retained Strength	Spec.
0.5	6.9	564	529	94%	85 Min



1/2" SP3 PG 58-28 ISPWC

Project Name: 2019 Commercial AC Designs
Technician: D. Kilmer
Date: 12/28/2018

Filename: Sunroc
Description: SP3
Nominal Sieve Size: 1/2"

Minus 0.4% -200

Sieve Size	Blends				
	Blend 1	Blend 2	Blend 3	Blend 4	Blend 5
B-Pile	24.0				
C-Pile	49.0				
RAP	27.0				

Sieve Size	Blends					Restricted Zone
	Blend 1	Blend 2	Blend 3	Blend 4	Blend 5	Zone
100.0	100.0	0.0	0.0	0.0	0.0	
50.00	100.0	0.0	0.0	0.0	0.0	
37.50	100.0	0.0	0.0	0.0	0.0	
25.00	100.0	0.0	0.0	0.0	0.0	
19.00	100.0	0.0	0.0	0.0	0.0	- 100
12.50	97.0	0.0	0.0	0.0	0.0	90 - 100
9.50	85.3	0.0	0.0	0.0	0.0	-
4.75	58.6	0.0	0.0	0.0	0.0	-
2.36	43.2	0.0	0.0	0.0	0.0	28 - 58
1.18	31.9	0.0	0.0	0.0	0.0	39.1 - 39.1
0.60	22.6	0.0	0.0	0.0	0.0	25.6 - 31.6
0.30	15.0	0.0	0.0	0.0	0.0	19.1 - 23.1
0.150	9.1	0.0	0.0	0.0	0.0	15.5 - 15.5
0.075	5.9	0.0	0.0	0.0	0.0	

Min/Max Limits

Sieve Size	Min/Max Limits
100.0	-
50.00	-
37.50	-
25.00	-
19.00	- 100
12.50	90 - 100
9.50	-
4.75	-
2.36	28 - 58
1.18	39.1 - 39.1
0.60	25.6 - 31.6
0.30	19.1 - 23.1
0.150	15.5 - 15.5
0.075	

Stockpiles

B-Pile	C-Pile	RAP
100.0	100.0	100.0
100.0	100.0	100.0
100.0	100.0	100.0
100.0	100.0	100.0
92.0	100.0	96.0
50.0	100.0	90.0
3.0	80.0	69.0
1.0	56.0	54.0
1.0	41.0	43.0
1.0	28.0	32.0
1.0	19.0	20.0
1.0	11.0	13.0
0.7	7.1	8.5

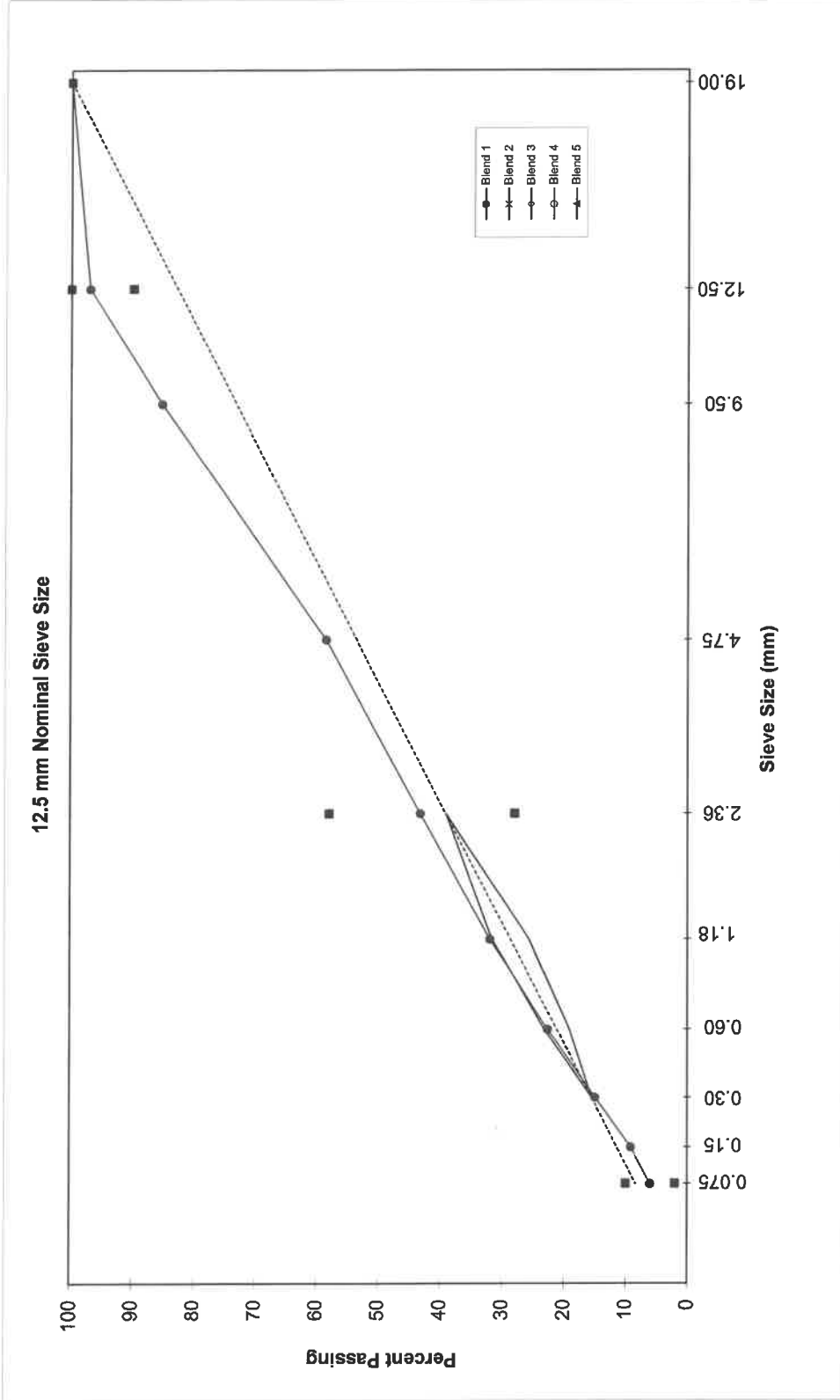
Specs.	Blends				
	Blend 1	Blend 2	Blend 3	Blend 4	Blend 5
Gsb					
Gsa					
% Absorption Sand Equiv.					
%Flat and Elongated Particles					
%Fine Ag. Ang.					
%Coarse Agg. Ang. (1 or more)					
%Coarse Agg. Ang. (2 or more)					
Va (assumed)					
Pb (assumed)					
Gse (est.)					
Ws					
Vba (est.)					
Vbe (est.)					
Pbi (est.)					

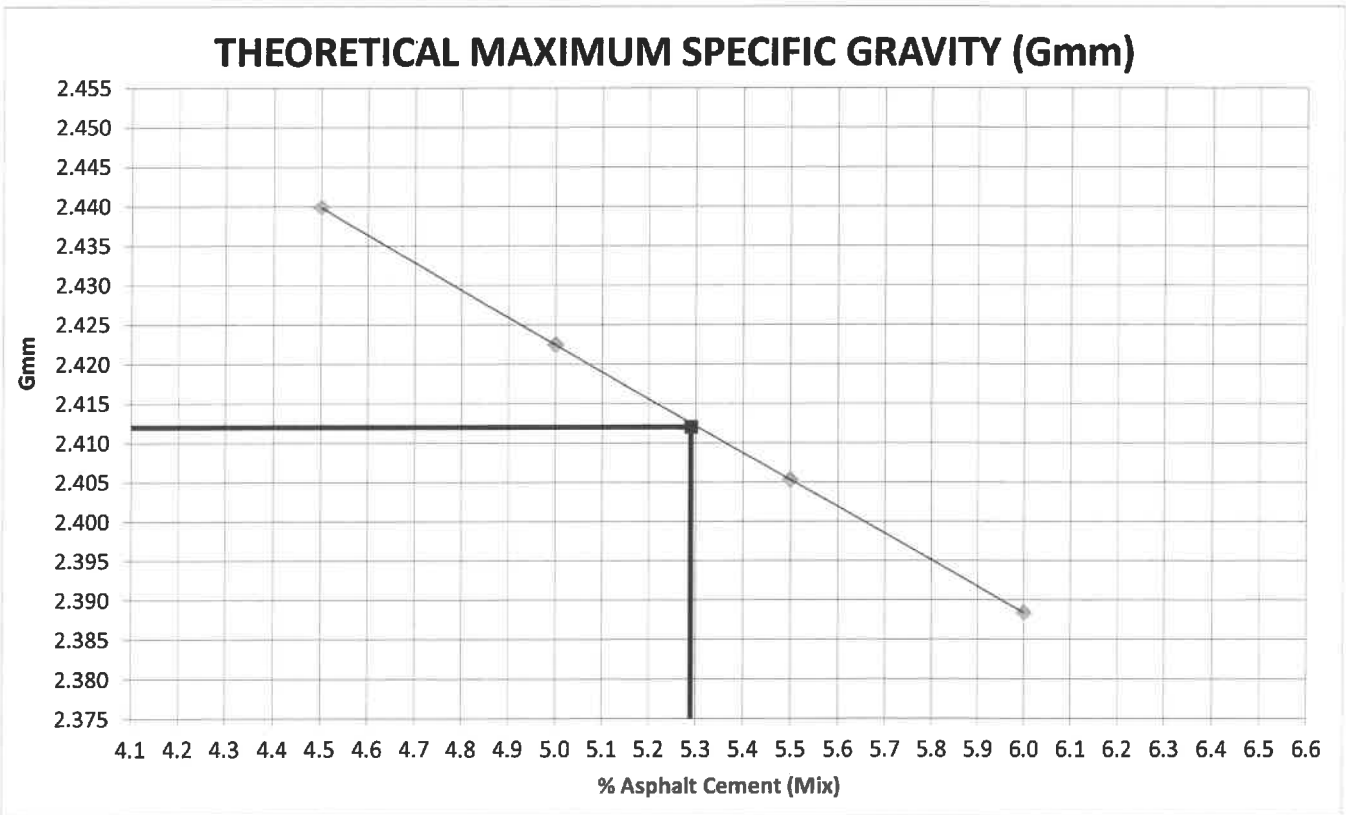
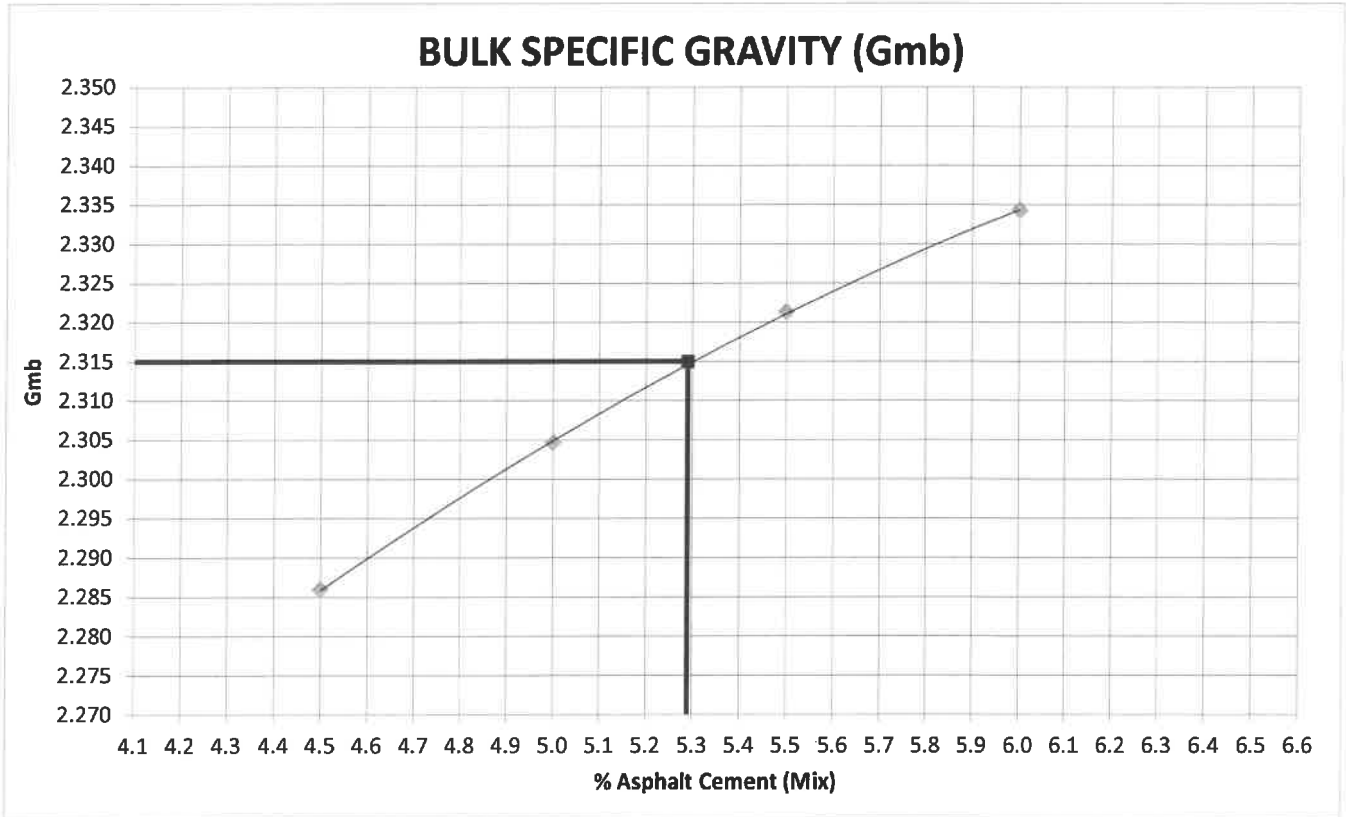
Absorption Multiplier
Gb
Traffic (million ESAL 's)
Depth from Surface (mm)

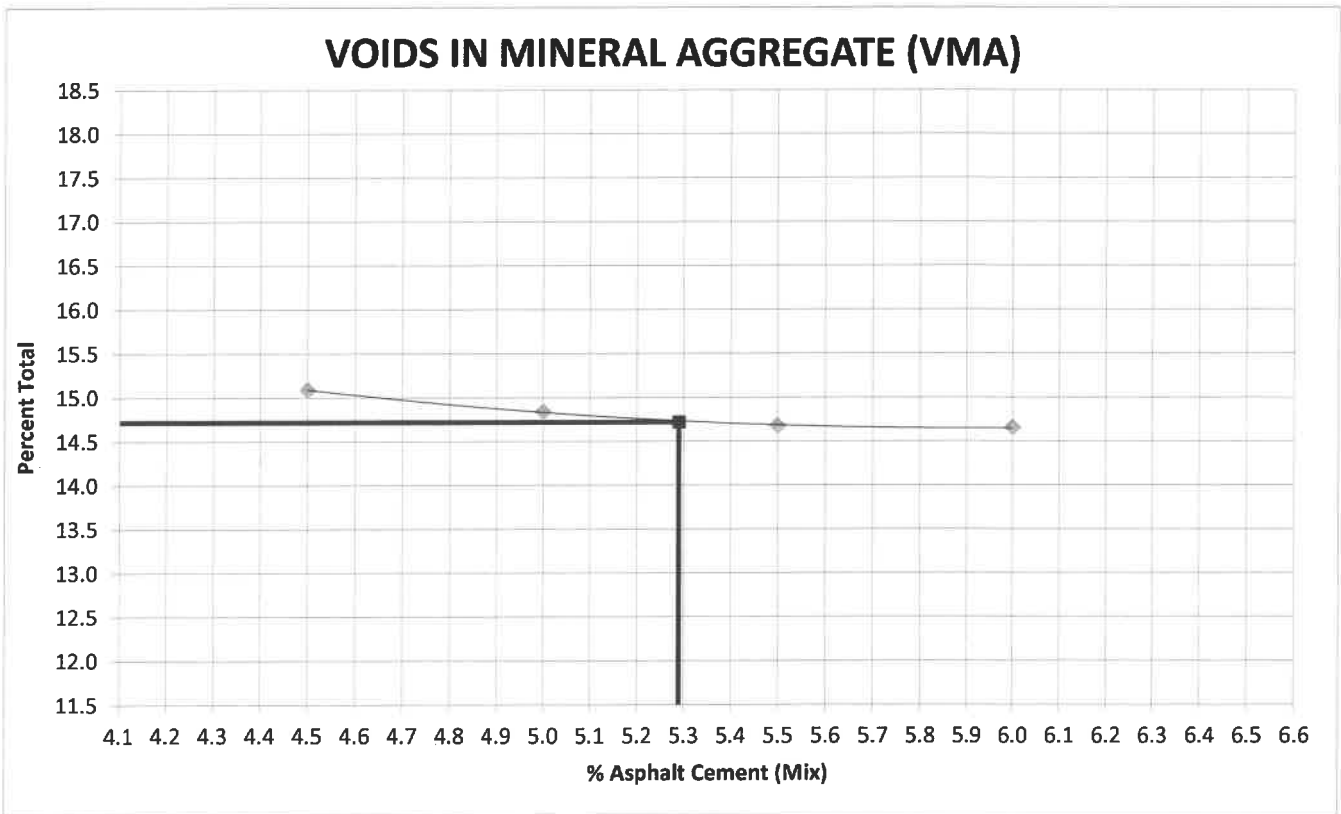
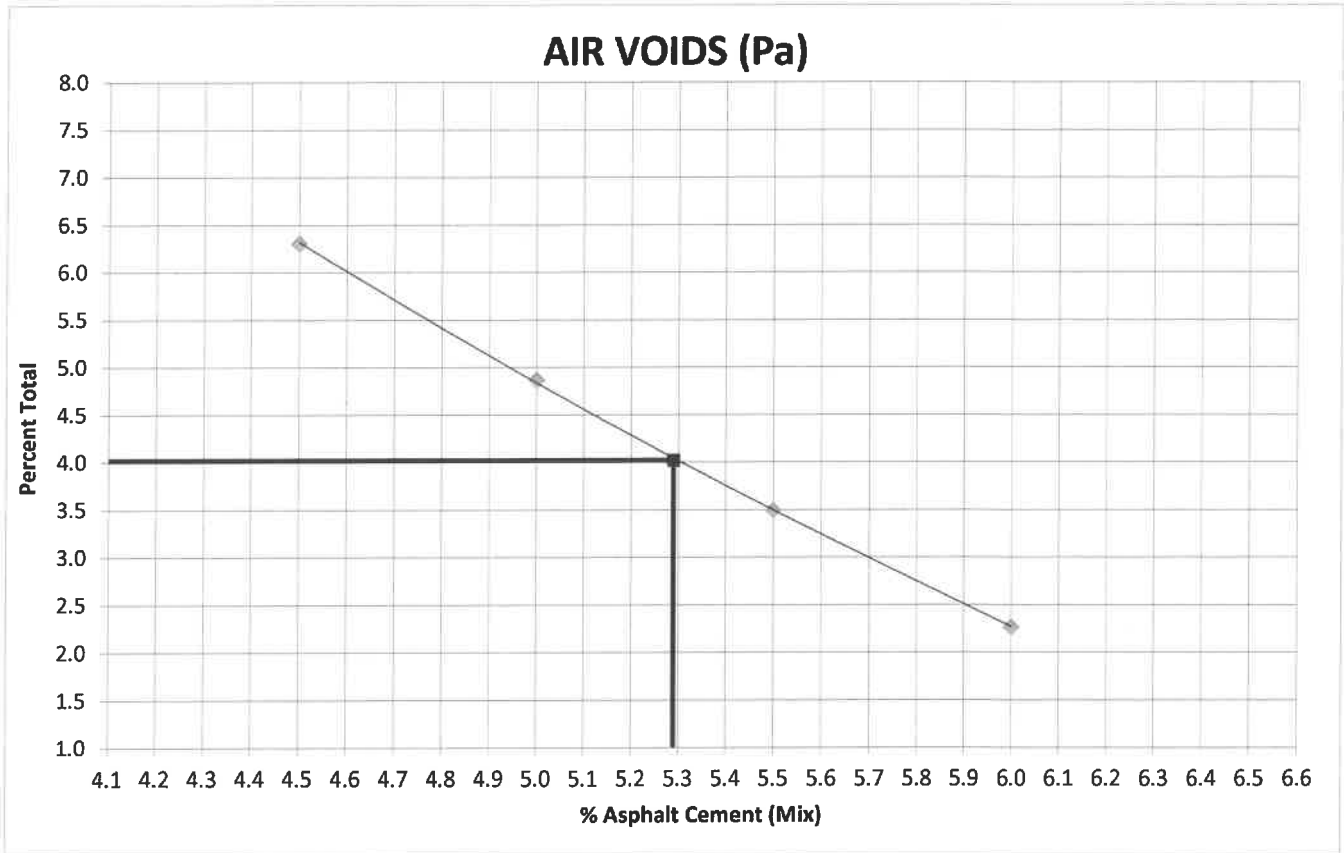
1/2" SP3 PG 58-28 ISPWC

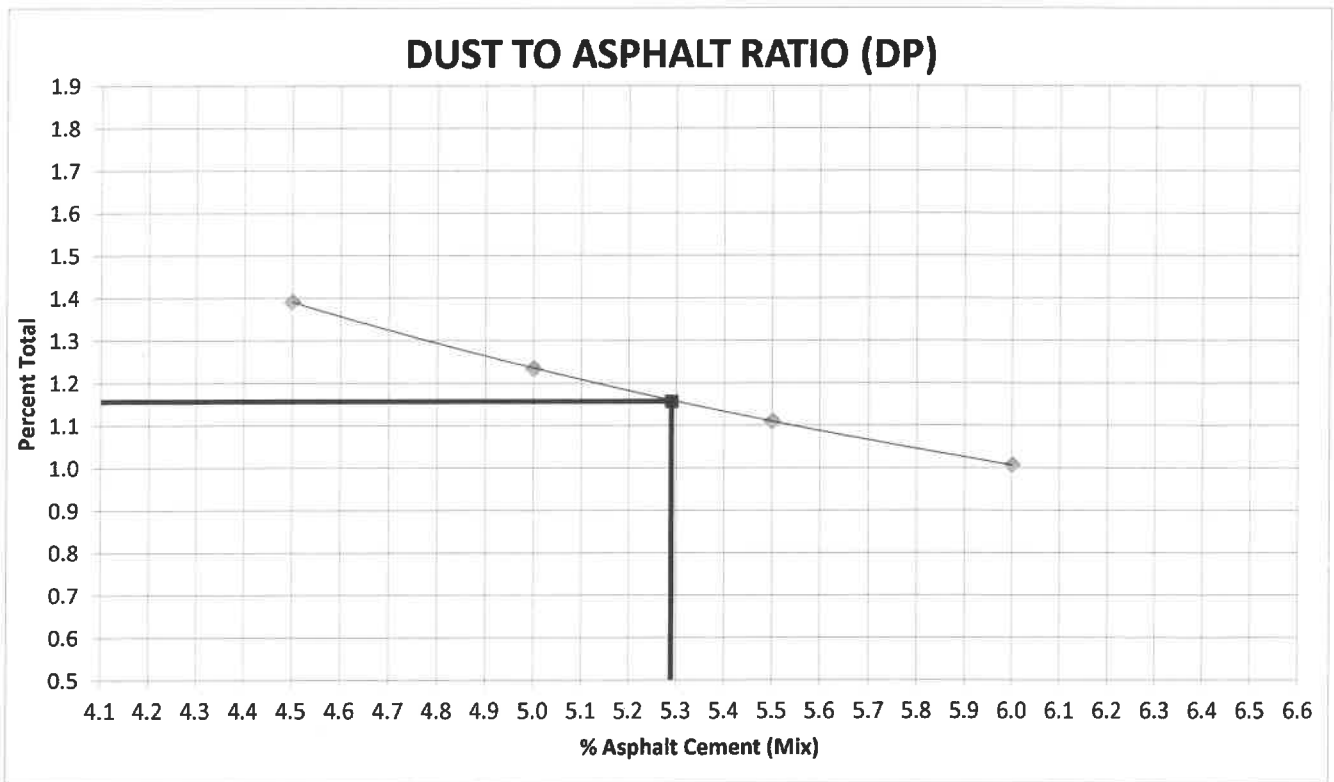
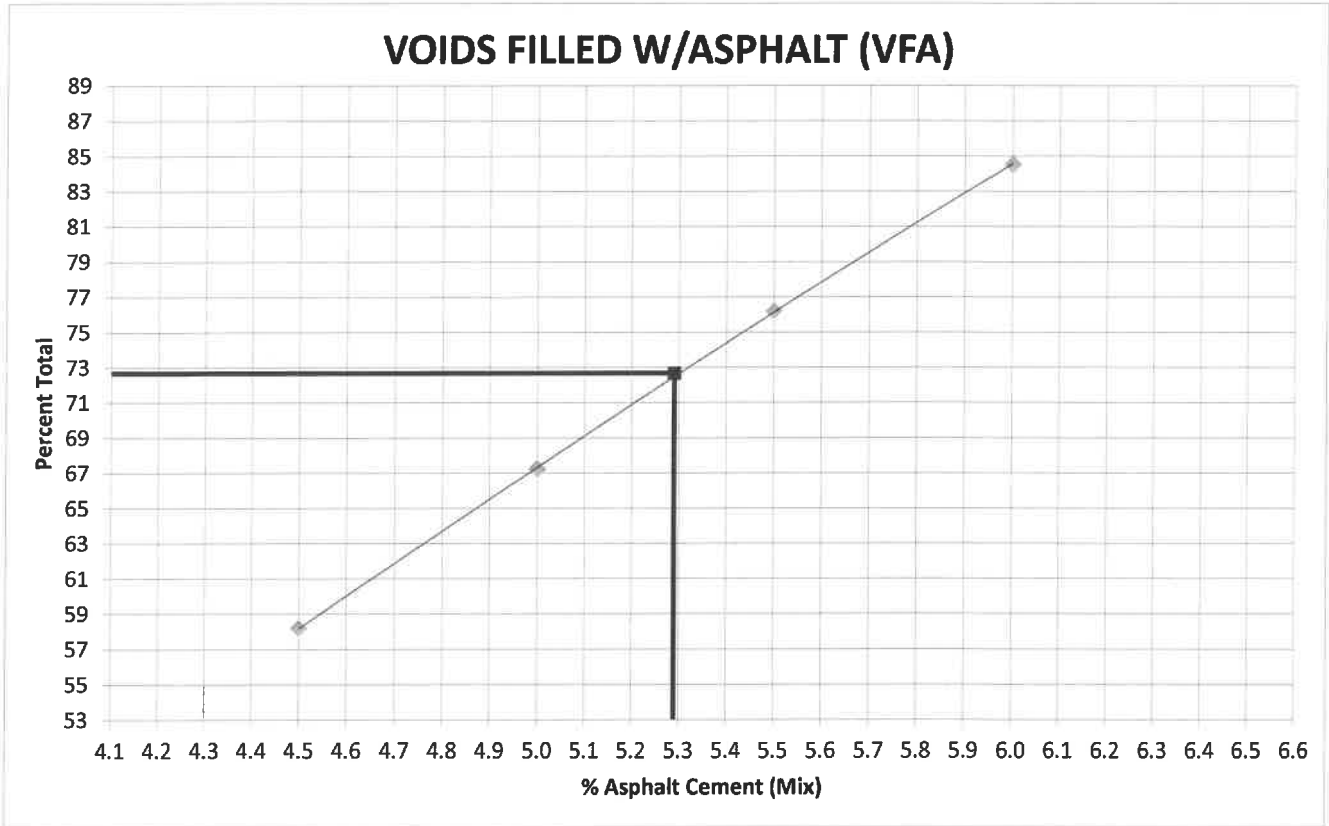
Project Name: 2019 Commercial AC Designs
Technician: D. Klimer
Date: 12/28/2018

Filename: Sunroc
Description: SP3
Nominal Sieve Size: 1/2"









Western States Asphalt

Typical Temperature-Viscosity Graph

Material
Specific Gravity, 15°C

PG 58-28
1.029

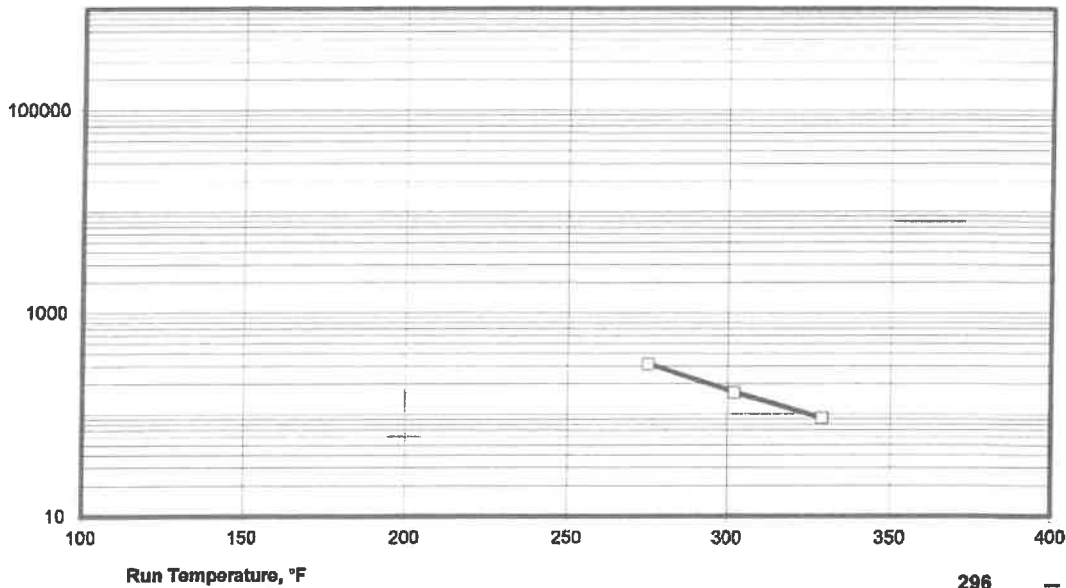
Recommended Mix and Compaction Temperature

PG 58-28	Mixing Hi Limit	303 °F
PG 58-28	Mixing Low Limit	296 °F
PG 58-28	Comp High Limit	283 °F
PG 58-28	Comp Low Limit	275 °F

Correlation 0.9997

Calculated Viscosity Chart

PG 58-28



296 — 303 °F
275 — 283 °F

*Note: Field Mixing and Compaction Temperatures
Can be increased or decreased 25°F, to allow for
construction conditions*

Test data reported herein has been secured by reliable Brookfield testing procedures. As we have no knowledge of, or control over the conditions that may affect the use of said material, we assume no responsibility in furnishing this data other than to warrant that they represent reliable measurements of the Brookfield Vis properties of the sample received and tested. Further these test results are non-specified and typical of the base-stock on hand at the time and date of the data request.

Report To: Sunroc Corp. Date: 5/23/2018
 Project No.: Category 2 RAP Sampled By: DH
 Client: Sunroc Tested By:
 Source: AD 152c

Project: Correction factor 0.38

Sieve Analysis AASHTO T-11, T-27

Screen	Size	Spec	Average	Date:											
				5/22/2018		5/23/2018		5/24/2018		5/25/2018		5/26/2018		5/27/2018	
				Time:		Time:		Time:		Time:		Time:		Time:	
				No:		No:		No:		No:		No:		No:	
				Tons X 100		Tons X 100		Tons X 100		Tons X 100		Tons X 100		Tons X 100	
				Sample No:		Sample No:		Sample No:		Sample No:		Sample No:		Sample No:	
3/4"	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
1/2"	96	96	96	97	98	95	96	97	97	96	97	96	97	96	97
3/8"	89	90	90	91	92	87	88	88	89	89	88	89	89	91	92
No. 4	68	69	69	64	77	66	69	63	67	63	65	65	63	70	74
No. 8	53	54	54	50	59	54	56	49	52	48	50	50	48	55	59
No. 16	42	43	43	39	47	44	45	40	41	38	40	40	38	44	47
No. 30	32	32	32	29	34	33	33	30	31	29	30	30	29	33	35
No. 50	21	20	20	18	21	20	20	19	19	19	20	20	19	21	22
No. 100	14	13	13	12	13	13	13	12	12	12	12	12	12	13	14
No. 200	9.2	8.5	8.5	8.3	8.5	8.3	8.1	7.6	7.8	7.9	7.8	7.8	7.9	8.7	9.2

Fractured Face	One or More	60 Min	100	100	100	100	100	100	100	100	100	100	100	100	100
Fractured Face	Two or More	60 Min	93	89	88	90	90	89	90	94	92	90	90	90	90
Gmm (rice)			2.568	2.571	2.567	2.576	2.577	2.557	2.560	2.560	2.560	2.560	2.560	2.560	2.560
Oil % by mix			5.79	6.06	6.06	5.78	5.97	5.64	5.79	5.29	6.02	5.22	5.87	5.87	5.87

Reviewed By: _____

SuperPave Production Test Report

ITD 0777 (Rev. 02-17)
itd.idaho.gov

Trial Verification

Contractor Acceptance

Key Number	Project Number 520-022	Project Name Commercial Asphalt Mix Designs	District
Identification Number Superpave HMA 1/2" SP3		Contract Item Number 810	Trial Verification
Send Reports To (Resident Engineer's Name) J. Towell		Prepared By D. Kilmer	WAQTC Number 22046
		Date Sampled	Date Lab Received
Binder Supplier Western States Asphalt		Asphalt Binder Grade PG 58-28	Class of Mix SP3
		CJMF Number A518-1042	
Station and Offset Lab Prepared		Source Number Ad-182c	Field Test Number
ESALs 1 -<3 SP3	Nominal Max Aggregate Size 1/2"	Primary Control Sieve No. 8	Percent Passing Primary Control Sieve 39 %

AASHTO T-209 Theoretical Max Specific Gravity (Bowl Method)

	Sample 1	Sample 2	
Wt. Bowl and Sample	1547.6	1544.1	
Wt. of Bowl	0.0	0.0	
Wt. of Sample (A)	1547.6	1544.1	
Wt. Bowl in Water with Sample	2274.3	2272.9	
Wt. of Bowl in Water	1369.3	1369.3	Average G _{mm}
Wt. of Sample in Water (B)	905.0	903.6	
G _{mm} (Maximum Specific Gravity)	2.408	2.411	2.410
$G_{mm} = A / (A - B)$			
Range		0.002	Acceptable? (Within d2s precision) YES

AASHTO T-166 Bulk Specific Gravity of Compacted Mix (Method A)

	Sample 1	Sample 2	
Wt. of Puck Dry (A)	4644.7	4642.3	
Wt. of Puck in Water (C)	2649.3	2645.0	Average G _{mb}
Wt. of Puck SSD (B)	4652.2	4649.7	
G _{mb} (Bulk Specific Gravity)	2.319	2.316	2.317
$G_{mb} = A / (B - C)$			
Range		0.003	Acceptable? (Within d2s precision) YES

G _{sb} - Aggregate Bulk SPG (from ITD 0802)	2.571
G _b - Specific Gravity of Binder (from Mix Design)	1.029
P ₂₀₀ - Percent Passing #200 (from ITD 0833)	5.5
P _b - Percent of Binder Content (from ITD 0833)	5.3
P _s - Percent of Aggregate (100 - Binder Content)	94.7
G _{se} - Aggregate Effective SPG	2.605
P _{be} - Percent of Effective Binder Content	4.80

AASHTO T-312-04 SuperPave Gyrotory Compactor

	Sample 1	Sample 2	
Compaction Temp.	280	280	Spec Limits 110 to 120
Sample Height (mm)	115.6	115.9	

Volumetric Properties

	Spec Limits
V _a - Lab Air Voids @ Ndesign $V_a = 100 \times (G_{mm} - G_{mb}) / G_{mm}$	3.8 3.0 5.0
VMA % - Voids in Mineral Aggregate $VMA = 100 - (G_{mb} \times P_s / G_{sb})$	14.6 > 14
VFA % - Voids Filled with Asphalt $VFA = 100 \times (VMA - V_a) / VMA$	73.9 60.0 80.0
DP - Dust Proportion $DP = P_{200} / P_{be}$	1.1 0.5 1.3

$$G_{se} = \frac{P_s}{\frac{100 - P_b}{G_{mm}} - \frac{P_b}{G_b}} \quad G_{se} = 2.605$$

$$P_{be} = P_b - (P_s \times G_b) \times \left[\frac{(G_{se} - G_{sb})}{(G_{se} \times G_{sb})} \right]$$

$$P_{be} = 4.80$$

Remarks

T-209 Tested By D. Kilmer	WAQTC Number 22046	Date Tested 01/23/20	T-166 Tested By D. Kilmer	WAQTC Number 22046	Date Tested 01/23/20
T-312 Tested By D. Kilmer	WAQTC Number 22046	Date Tested 01/23/20	Checked By J. Calkins	WAQTC Number 23528	Date Checked 01/23/20