Asphaltic Concrete Mix Design
Marshall Method

Date: June 8, 2010

Project No: VB052810-108

Mix Type/Specification: APWA Type 3-01

For: Mr. Leland Smith
Vance Brothers, Inc.
5201 Brighton Ave.
Kansas City, MO 64130

Asphaltic Concrete Mix Design – APWA Type 3-01

Objective

Perform a Marshall Mix Design per the Asphalt Institute MS-2 Manual and AASHTO test methods conforming to the Kansas City Metropolitan Chapter of the American Public Works Association, 2001 Edition, APWA Type 3-01 specification (50 compaction blows per face).

Materials

Material	Source	Date Received
1/2" Crushed Limestone	Quality Quarry, KCMO	March 15, 2010
3/8" Crushed Limestone	Quality Quarry, KCMO	March 15, 2010
Limestone Screenings	Quality Quarry, KCMO	March 15, 2010
River Sand	Mid America Sand Co., KCMO	March 15, 2010
PG 64-22 Asphalt	Conoco Phillips, Wood River, IL	December 30, 2009

Discussion: Mix Design Project VB 052810-108

The mix design was optimized using four asphalt contents (4.0, 4.5, 5.0, 5.5 AC). The table below lists the mix properties at the optimum asphalt content chosen (4.3% AC). The mixing temperature range is 305 to 315°F and the compaction temperature range is 285 to 295°F. As with any mix, compaction and compaction temperatures should be determined by roller test patterns and density measurements. These test results apply only to the laboratory samples as received. Adjustments may be necessary in the plant/field due to raw material variation, conditions in the plant/field, etc. Mix design tables and graphs are on pages 2 – 5.

Property	APWA 3-01 Specification	Mix Properties
Optimum AC Content (%)	NA	4.3 +/- 0.2
Bulk Gravity of Mix (G_{mb})	NA	2.394
Mix Density (lbs/ft^3)	NA	149.4
% Air Voids	3 - 5	3.5
% VMA	NA (AI MS-2: 14 min.)	11.3
% Voids Filled	NA (AI MS-2: 65 - 78)	69.2
Dust Proportion	NA (AI MS-2: 0.6 - 1.2)	1.88
Stability (lbs)	1,500 min.	2,850
Flow (0.01")	8 - 16	13

Note: NA = Not Applicable - AI MS-2 Specifications are provided for information only.

Reviewed by: Martin R. Burrow Date: June 8, 2010

Martin R. Burrow
Technical Director, Vance Brothers

Vance Brothers, Inc. 5201 Brighton, Kansas City, MO 64130 Tel: 816-923-4325 Fax: 816-923-6472 e-mail: mburrow@vancebrothers.com Website: http://www.vancebrothers.com

Project VB052810-108 cont'd.

Project Number : VB 041910-02
Project Location : Vance Brothers Kansas City
Date : 4/19/2010

ASPHALT INSTITUTE
Marshall Mix Design
Program

Material Description

Aggregate 1 = 1/2" Quality
Aggregate 2 = 3/8" Quality
Aggregate 3 = Quality Lime
Aggregate 4 = Mid American Asphalt Sand
Aggregate 5 =
Aggregate 6 =
Aggregate 7 =
Aggregate 8 =
Aggregate 9 =
Aggregate10 =

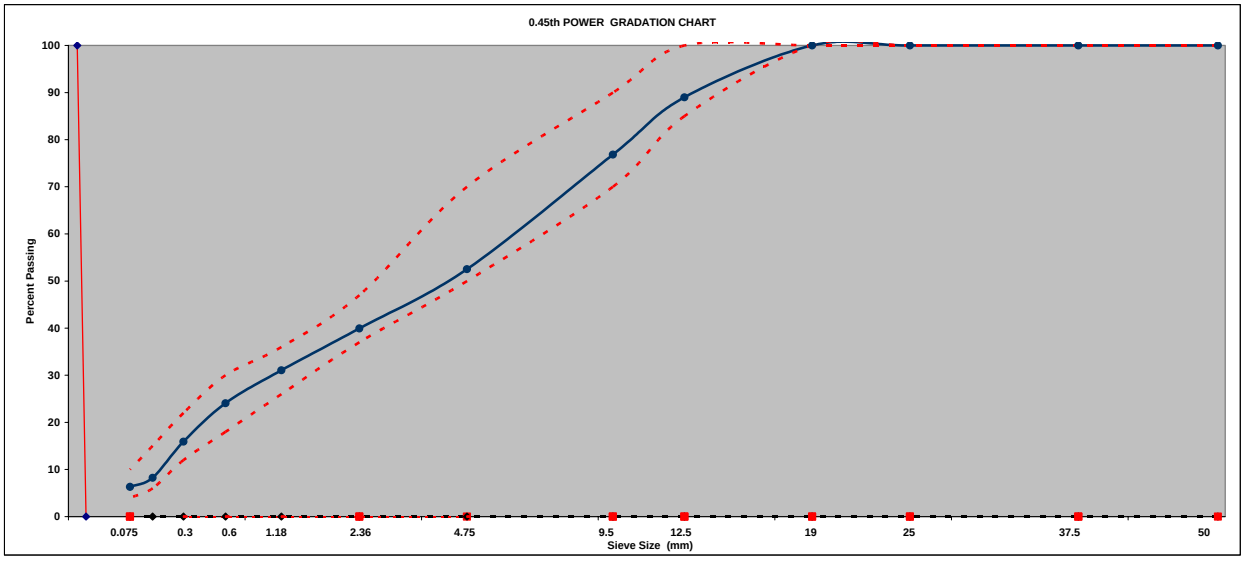
Enter Estimated Binder %
Estimated Mix Cost $ -

Enter Aggregate Material Data in this Table

Enter Nominal Maximum Size of the Mixture mm

Stockpile Percentage

Aggregate Cost		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -		
Sieve Size		28%	28%	29%	15%								Specifications	
mm	US	Agg.1	Agg.2	Agg.3	Agg.4	Agg.5	Agg.6	Agg.7	Agg.8	Agg.9	Agg.10	Composite	Min.	Max.
50	2"	100.0	100.0	100.0	100.0							100.0	100	100
37.5	1 1/2"	100.0	100.0	100.0	100.0							100.0	100	100
25	1"	100.0	100.0	100.0	100.0							100.0	100	100
19	3/4"	100.0	100.0	100.0	100.0							100.0	100	100
12.5	1/2"	60.7	100.0	100.0	100.0							89.0	85	100
9.5	3/8"	17.3	100.0	100.0	100.0							76.8	70	90
4.75	#4	1.3	29.3	100.0	99.6							52.5	50	70
2.36	#8	1.2	5.7	82.2	94.5							39.9	37	47
1.18	#16	1.2	4.0	57.6	86.0							31.1	26	36
0.6	#30	1.1	3.4	40.8	73.2							24.1	18	30
0.3	#50	1.0	3.1	29.1	42.1							15.9	12	22
0.15	#100	0.9	2.9	21.9	5.5							8.2	6	15
0.075	#200	0.7	2.7	18.2	0.5							6.3	4.0	10.0



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Project VB052810-108 cont'd.

ASPHALT INSTITUTE
Marshall Mix Design
Program

Project Number : VB 041910-02
Project Location : Vance Brothers Kansas City

28%	Aggr.1 =	1/2" Quality		Aggr.6 =	
28%	Aggr.2 =	3/8" Quality		Aggr.7 =	
29%	Aggr.3 =	Quality Lime		Aggr.8 =	
15%	Aggr.4 =	Mid American Asphalt Sand		Aggr.9 =	
	Aggr.5 =			Aggr.10 =	

Pb	5.00%
Gmm	2.456
Gb	1.035
Calculate Gse	2.64754
Calculate Pba	0.96

CAA Test

Weight of 1- Frac Face sample		percent 1 or more FF	
Weight of 2- Frac Face sample		percent 2 or more FF	
Total dry weight of sample			

FAA Test

	Spec. 1	Spec. 2
Volume of cylinder (cm³)		
Wt. of cylinder (g)		
Wt. of cylinder + Sample (g)		
Gsb of fine aggregate	2.549	2.549
Percent uncompacted voids		
Ave. % Uncompacted Voids		

Sand Equiv. Test

	Sand Rdg.	Clay Rdg.	S.E.
Reading #1			
Reading #2			
Reading #3			
Average			

Gsb Coarse Sample

Spec. #	Dry Wt.	Sub. Wt	SSD Wt.	Gsb	Gsa	Abs
1	2353.1	1484.4	2381.1	2.624	2.709	1.19%
2	2353.1	1484.4	2381.1	2.624	2.709	1.19%
		Average		2.624	2.709	1.19%

Flat and Elongated Particles

Total weight of dry sample	
Dry wt. of elongated particles	
% of Elong. Particles	

Gsb Fine Sample

Spec. #	Oven Dry Sp. In Air	Flask + H_20	FL+H20 + Spec.	Gsb	Gsa	Abs
1	487.1	1261.9	1570.8	2.549	2.733	2.65%
2	487.1	1261.9	1570.8	2.549	2.733	2.65%
			Average	2.549	2.733	2.65%

Combined Gsb =	2.584
Combined Gsa =	2.722
Comb. H2O Abs. =	1.67%

G_{mm} @ 5.00% Apshalt Binder

Specimen No.	Sample in air	Sample & Bowl in H_2O	Bowl in H20	Sample in H20	Gmm	Ave. Gmm
1	1500.0	6347.7	5459.0	888.7	2.454	2.456
2	1500.0	6348.9	5459.0	889.9	2.459	

		Data Entry					Volumetric Data												
SPEC. NO.	Pb	DRY WT.	SUB WT.	SSD WT.	Gmb	Ave. Gmb	Gmm	Va	VMA	VFA	Pbe	DP	Stab.	Ave. Stab.	Vol.	Corr. Factor	Corr. Stab	Flow	Ave. Flow
1A	4.0%	1196.2	697.6	1201.7	2.373								2950					11.0	
1B	4.0%	1194.2	696.7	1200.1	2.372	2.376	2.492	4.66%	11.73	60.26	3.08	2.05	2900	3017	501	1.04	3137	12.0	11.7
1C	4.0%	1186.5	694.1	1192.0	2.383								3200					12.0	
2A	4.5%	1193.6	701.8	1197.3	2.409								2650					13.0	
2B	4.5%	1190.5	698.1	1194.2	2.400	2.406	2.474	2.75%	11.08	75.16	3.58	1.76	2600	2567	496	1.04	2669	13.0	13.3
2C	4.5%	1196.0	702.7	1199.1	2.409								2450					14.0	
3A	5.0%	1195.0	700.1	1196.0	2.410								1450					17.0	
3B	5.0%	1190.6	698.4	1192.0	2.412	2.411	2.456	1.83%	11.36	83.86	4.09	1.54	1550	1517	495	1.09	1653	16.0	17.0
3C	5.0%	1197.9	703.3	1200.0	2.412								1550					18.0	
4A	5.5%	1194.2	701.0	1195.2	2.416								1100					18.0	
4B	5.5%	1191.6	699.0	1192.6	2.414	2.414	2.439	1.00%	11.71	91.49	4.59	1.37	1050	1043	493	1.09	1137	17.0	18.0
4C	5.5%	1188.3	696.8	1189.4	2.412								980					19.0	
5A																			
5B																			
5C																			

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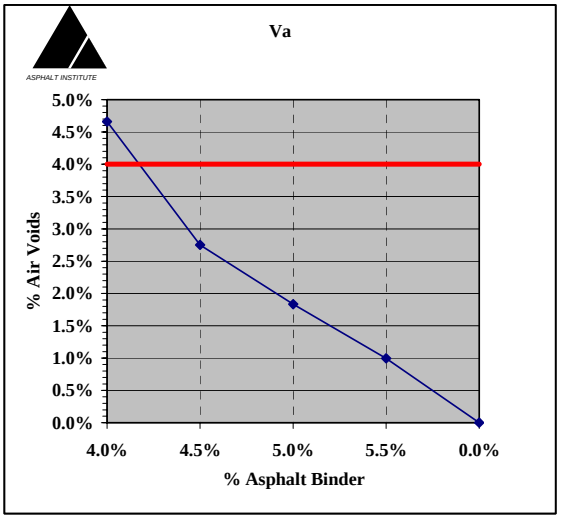
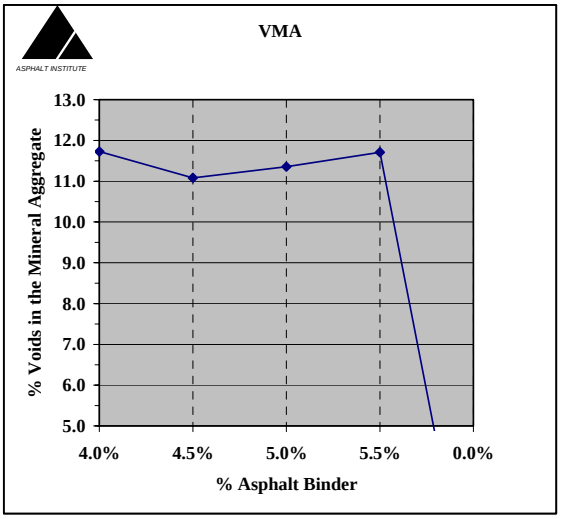
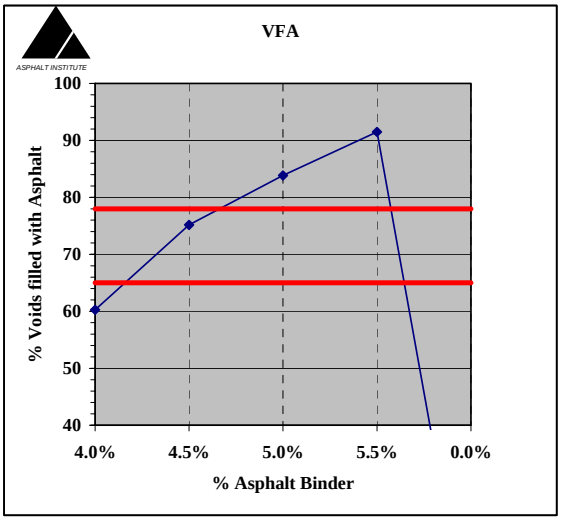
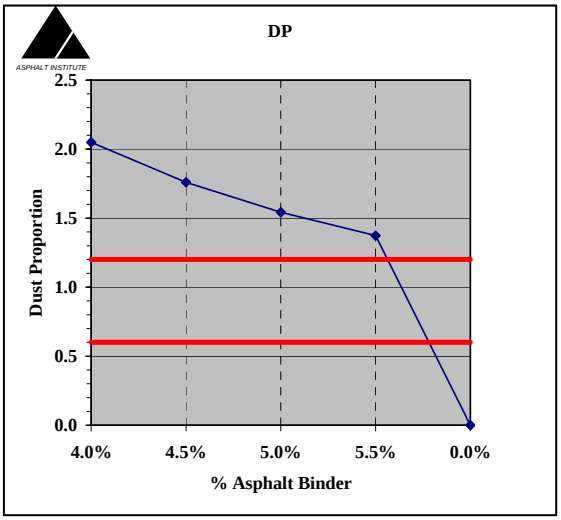
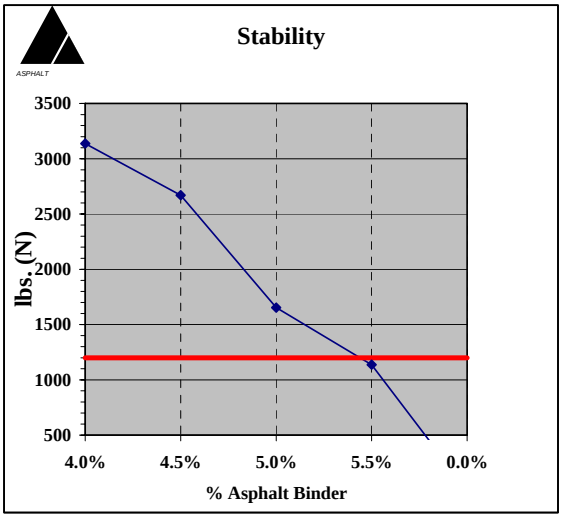
Project VB052810-108 cont'd.

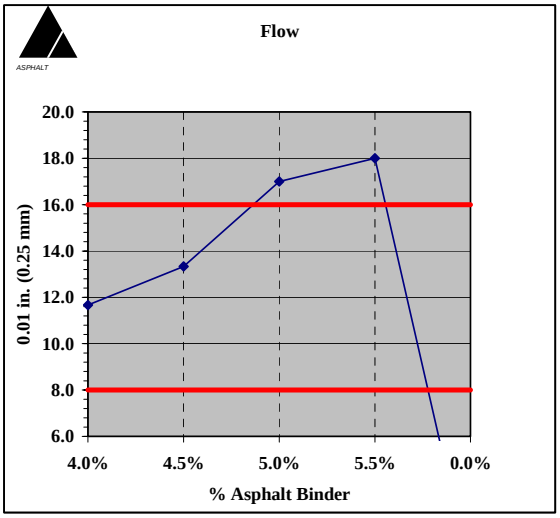












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ConocoPhillips

Wood River Refinery
Roxana, Illinois

Certificate of Analysis

Product Name : Superpave PG 64-22
Product Code : 90084
Customer : BRENNTAG
MID-SOUTH-KANSAS CITY, MO

Report Date : Dec 30 2009 8:12AM
Date Sampled : Dec 13 2009 6:30AM
Date Shipped : 12/30/2009

Sample ID : 5353357
Cert ID : 129502
Blend Tank : A-155

Carrier : GATX56593, UTLX646367, UTLX644031, UTLX645211, SRIX80066

Name		Units	Results	Specs Min	Specs Max	Notes
D-5 Penetration-D5 Pen @25C	Penetration	mm	69.0			
D-70 Sp. Grav.-D70 @ 60F	API Gravity		5.999			
D-70 Sp. Grav.-D70 @ 15.6C	Specific Gravity		1.0291			
D-92 COC Flash-D0092 (C)	Flash Point	Deg C	316.	230		
D-2171 Vac Visc-D2171@140F	Absolute Viscosity	Poise	2009.			
D-4402 Visc-D4402 Rot Vis	Rotational Viscosity	Pa-s	0.393		3	
AASHTO T-315-Orig DSR@64C	Dynamic Shear (G*/sin d)	kPa	1.29	1.00		
D-2872 RTFO-D2872	Mass Loss	Wt %	0.059	-1.00	1.00	
AASHTO T-315-RTFO DSR@64C	Dynamic Shear (G*/sin d)	kPa	3.09	2.20		
AASHTO T-315-PAV DSR@25C	Dynamic Shear (G* sin d)	kPa	3794.		5000	
AASHTO T-313-BBR@-12C	Average Stiffness	M-Pa	168.		300	
	Average M-Value		0.324	.300		

Comments :
Certifies above material meets AASHTO M 320 for performance graded (PG) Asphalt. Quality Assurance: Dave Suess 618.255.

Please direct questions to David Suess at (618) 255-2758 or Dave.Suess@ConocoPhillips.com

Feb 16 2010 11:06 BRENNTAGJET FAX 8164543301 p.1
12/30/2009 09:31 6182553114 GALE SMAY PAGE 06/06