



# Asphaltic Concrete Mix Design Marshall Method

Date: February 23, 2010

Project No: VB012910-103

Mix Type/Specification: APWA RC-Type 1-01

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

# Asphaltic Concrete Mix Design – APWA RC-Type 1-01

## 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 RC-Type 1-01 (50 compaction blows per face).

## Materials

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

## Discussion: Mix Design Project VB012910-103

The mix design was optimized using four asphalt contents (4.5, 5.0, 5.5, 6.0, AC). The table below lists the mix properties at the optimum asphalt content chosen (4.5% Total – 3.5% virgin AC). The mixing temperature range is 305 to 315°F and the compaction temperature range is 285 to 295°F. All loose mix was aged for 2 hours at compaction temperature before testing. 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 RC-Type 1-01 Specification	Mix Properties
Optimum AC Content (%)	NA	4.5 +/- 0.2 (3.5% virgin AC)
Bulk Gravity of Mix ( $G_{mb}$ )	NA	2.421
Mix Density (lbs/ft <sup>3</sup> )	NA	150.7
% Air Voids	3 - 5	4
% VMA	NA (AI MS-2: 12 min.)	12.3
% Voids Filled	NA (AI MS-2: 65 - 78)	67.5
Dust Proportion	NA (AI MS-2: 0.6 - 1.2)	0.93
Stability (lbs)	1,500 min.	2800
Flow (0.01")	8 - 16	15.0

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

Reviewed by: *Martin R. Burrow*  
Martin R. Burrow  
Technical Director, Vance Brothers

Date: February 23, 2010

Project VB012910-103 cont'd.

Project Number : VB 012910-103

Project Location : Kansas City MO HMA Plant

Date : 1/29/2010



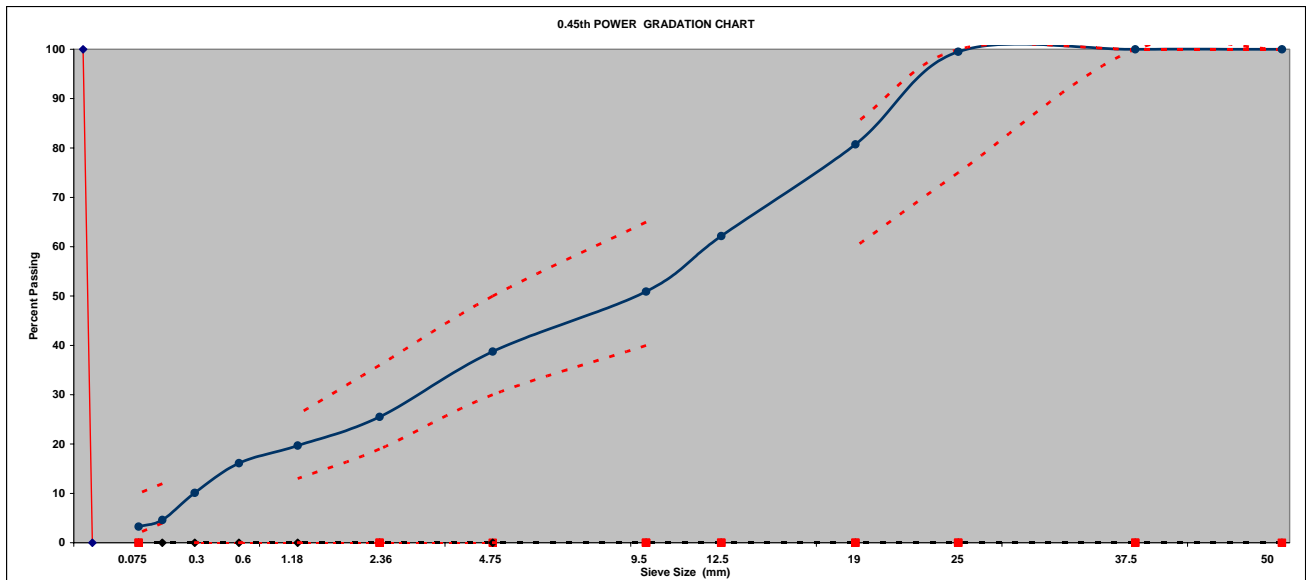
**Material Description**

- Aggregate 1 = 1" Crushed Lime Quality
- Aggregate 2 = 1/2" Crushed Lime Quality
- Aggregate 3 = Lime Dust Quality
- Aggregate 4 = Asphalt Sand Mid America
- Aggregate 5 = RAP VB MO
- Aggregate 6 =
- Aggregate 7 =
- Aggregate 8 =
- Aggregate 9 =
- Aggregate 10 =

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	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	Specifications		
Sieve Size	32%	23%	18%	8%	19%							Composite	Min.	Max.
mm	US	Agg.1	Agg.2	Agg.3	Agg.4	Agg.5	Agg.6	Agg.7	Agg.8	Agg.9	Agg.10			
50	2"	100.0	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						100.0	100	100
25	1"	98.5	100.0	100.0	100.0	100.0						99.5	75	100
19	3/4"	39.8	100.0	100.0	100.0	100.0						80.7	60	85
12.5	1/2"	3.4	71.8	100.0	100.0	97.7						62.2		
9.5	3/8"	2.7	27.2	100.0	100.0	93.6						50.9	40	65
4.75	#4	2.1	2.2	99.2	99.8	61.7						38.7	30	50
2.36	#8	2.0	1.9	53.6	97.1	37.0						25.5	19	36
1.18	#16	1.9	1.7	32.2	92.7	28.9						19.7	13	26
0.6	#30	1.8	1.5	22.7	83.5	23.4						16.1		
0.3	#50	1.6	1.3	16.2	45.6	14.4						10.1		
0.15	#100	1.4	1.1	12.3	5.9	6.5						4.6	4	12
0.075	#200	1.2	0.9	10.2	0.6	4.3						3.3	2.0	10.0



Project VB012910-103 cont'd.


 Project Number : VB 012910-103  
 Project Location : Kansas City MO HMA Plant

32%	Aggr.1 = 1" Crushed Lime Quality	Aggr.6 =
23%	Aggr.2 = 1/2" Crushed Lime Quality	Aggr.7 =
18%	Aggr.3 = Lime Dust Quality	Aggr.8 =
8%	Aggr.4 = Asphalt Sand Mid America	Aggr.9 =
19%	Aggr.5 = RAP VB MO	Aggr.10 =

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			

Gsb Coarse Sample						
Spec. #	Dry Wt.	Sub. Wt	SSD Wt.	Gsb	Gsa	Abs
1	2046.0	1300.5	2068.0	2.666	2.744	1.08%
2	2046.0	1300.5	2068.0	2.666	2.744	1.08%
Average				2.666	2.744	1.08%

Gsb Fine Sample						
Spec. #	Oven Dry	Flask + H <sub>2</sub> O	FL+H <sub>2</sub> O + Spec.	Gsb	Gsa	Abs
1	493.7	1261.9	1571.1	2.588	2.676	1.28%
2	493.7	1261.9	1571.1	2.588	2.676	1.28%
Average				2.588	2.676	1.28%

FAA Test	Spec. 1	Spec. 2
Volume of cylinder (cm <sup>3</sup> )		
Wt. of cylinder (g)		
Wt. of cylinder + Sample (g)		
Gsb of fine aggregate	2.588	2.588
Percent uncompact voids		
Ave. % Uncompact voids		

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

Combined Gsb =	2.635
Combined Gsa =	2.717
Comb. H <sub>2</sub> O Abs. =	1.15%

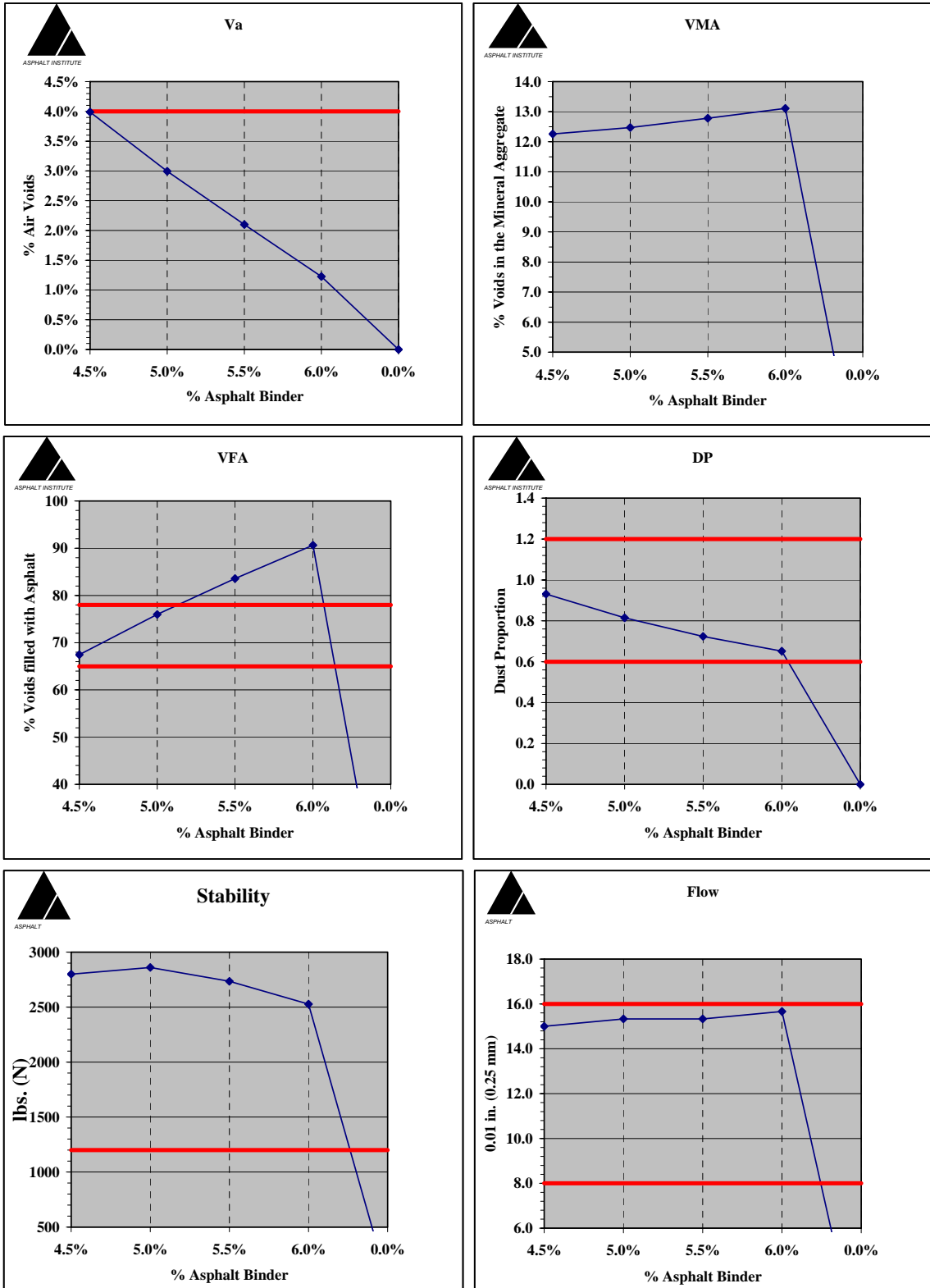
Pb	5.50%
Gmm	2.484
Gb	1.035
Calculate Gse	2.70443
Calculate Pba	1.01

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

G <sub>mm</sub> @	5.50%	Apshalt Binder				
Specimen No.	Sample in air	Sample & Bowl in H <sub>2</sub> O	Bowl in H <sub>2</sub> O	Sample in H <sub>2</sub> O	Gmm	Ave. Gmm
1	1500.0	6355.4	5459.0	896.4	2.485	2.484
2	1500.0	6354.9	5459.0	895.9	2.483	

SPEC. NO.	Pb	Data Entry			Gmb	Ave. Gmb	Volumetric Data					Stab.	Ave. Stab.	Vol.	Corr. Factor	Corr. Stab	Flow	Ave. Flow
		DRY WT.	SUB WT.	SSD WT.			Gmm	Va	VMA	VFA	Pbe							
1A	4.5%	1216.6	722.0	1221.5	2.436	2.421	2.521	3.99%	12.26	67.46	3.54	0.93	2625	2692	501	1.04	2799	14.0
1B	4.5%	1211.3	714.9	1216.8	2.413								2825					17.0
1C	4.5%	1211.3	714.9	1216.8	2.413								2625					14.0
2A	5.0%	1216.8	718.8	1220.0	2.428	2.428	2.503	2.99%	12.47	76.00	4.04	0.81	2775	2750	498	1.04	2860	16.0
2B	5.0%	1197.9	707.0	1200.4	2.428								2725					15.0
2C	5.0%	1217.1	719.1	1220.5	2.427								2750					15.0
3A	5.5%	1181.7	697.0	1182.6	2.433	2.432	2.484	2.10%	12.78	83.57	4.55	0.72	2450	2508	488	1.09	2734	16.0
3B	5.5%	1194.2	703.8	1195.2	2.430								2525					15.0
3C	5.5%	1190.0	702.0	1191.3	2.432								2550					15.0
4A	6.0%	1169.1	690.2	1171.1	2.431	2.436	2.466	1.23%	13.11	90.65	5.05	0.65	2300	2217	481	1.14	2527	16.0
4B	6.0%	1176.2	694.0	1177.1	2.435								2250					15.0
4C	6.0%	1172.4	693.5	1173.8	2.441								2100					16.0
5A																		
5B																		
5C																		

Project VB012910-103 cont'd.



Project VB012910-103 cont'd.



 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, SRDX80066**

Name	Units	Results	Specs		Notes
			Min	Max	
D-5 Penetration-D5 Pen @28C	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-D9092 (C)	Flash Point	Deg C	318.	230	
D-2171 Vac Viso-D2171@140F	Absolute Viscosity	Poise	2009.		3
D-4402 Viso-D4402 Rot Vis	Rotational Viscosity	Pa-s	0.393		
AASHTO T-315-Orig DSR@64C	Dynamic Shear (G°/sin d)	kPa	1.29	1.00	
D-2672 RTFO-D2672	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

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