



3/10/2014

Martin Marietta Materials, Inc.
10170 Church Ranch Way, Suite 200
Westminster, CO 80021

Attn: Mr. Pat Hartshorn

Re: Hot Mix Asphalt Mix Design

Grading:	1/2" NMAS
Method/Type:	Superpave 75 Gyration
Aggregate:	Spec Agg/Riverbend/Cottonwood/RAP
Plant Number(s):	16318, 16321
Mix Design Number:	1243
Product Number:	5462
Ticket Description:	(1/2)SP75(64-22)20%

This letter represents the results of a hot mix asphalt mixture design by the Superpave Method, utilizing 75 Gyration at 1.25° in accordance with Colorado Department of Transportation Manual of Test Procedures and as outlined by Asphalt Institute Manual, Series No.2 (SP-2).

The Spec Agg/Riverbend/Cottonwood/RAP aggregates and HollyFrontier PG 64-22 asphalt cement used in this mix design were proportioned in accordance with your request as detailed in the blend table of this design.

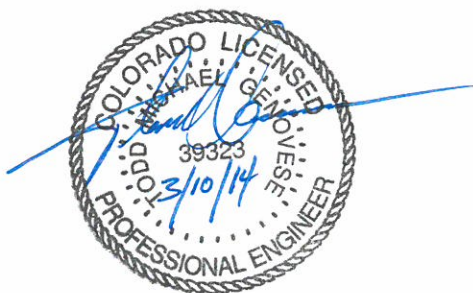
Properties of this mixture are:

Asphalt Content (%AC):	5.40	
Max. Theoretical Specific Gravity (Gmm):	2.484	(155. pcf)
Air Voids (%Va):	3.9	
Voids in Mineral Aggregate (%VMA):	15.0	
Voids Filled with Asphalt (%VFA):	74.2	
Tensile Strength Ratio, TSR (%):	98	
Hveem Stability:	41	

The aggregate blend sheet, mix design physical properties, mix design property curves, and combined aggregate properties are presented on the enclosed forms.

Please do not hesitate to contact us with any questions concerning this report.

Sincerely,
Martin Marietta Materials, Inc. - Central Laboratory
An AASHTO Accredited Lab



Todd M. Genovese, P.E.
QC Manager - Rocky Mountain Division
Enclosures

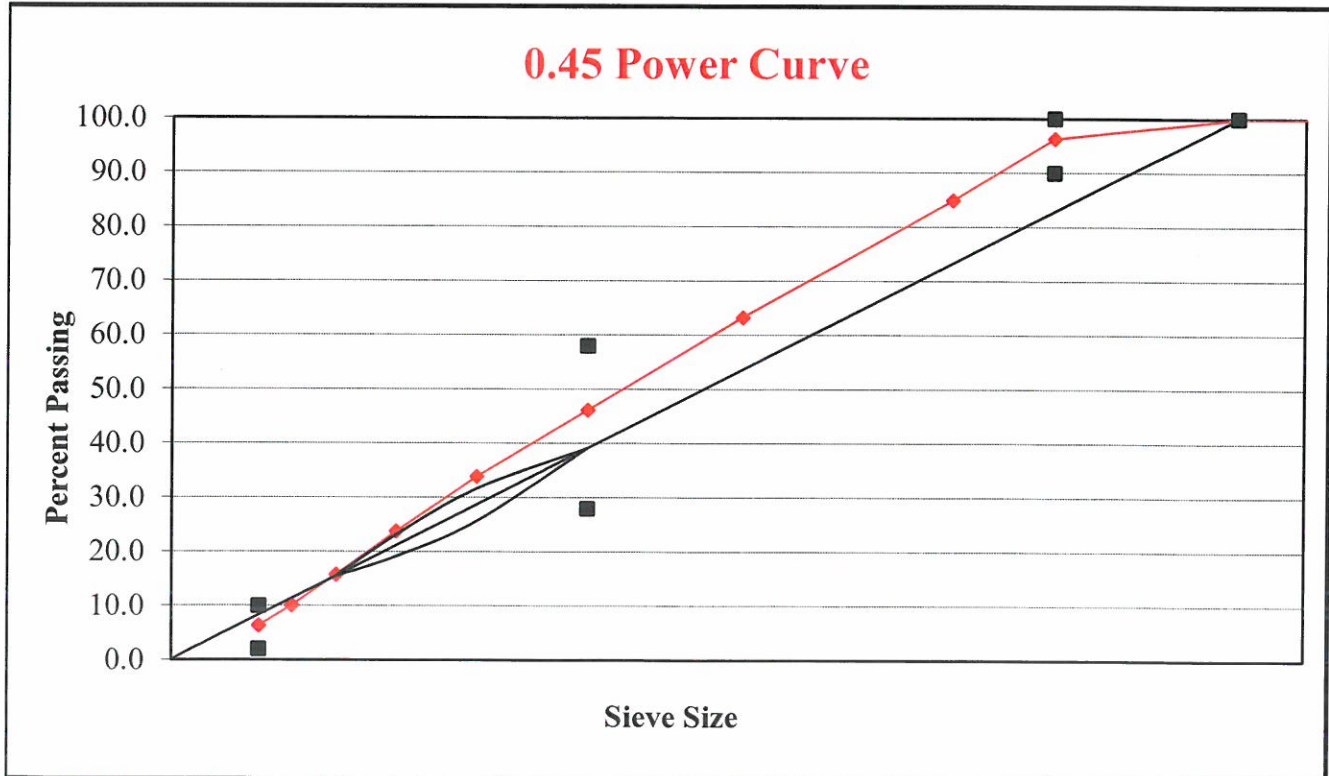
Martin Marietta Materials



Date: 3/10/2014
Design Number: 1243
Grading: 1/2" NMAAS
Design Type: Superpave 75 Gyration
Aggregate Source: Spec Agg/Riverbend/Cottonwood/RAP

Client: Metro Asphalt
Binder: PG 64-22
Supplier: HollyFrontier
Specific Gravity: 1.026
Additive: Lime

% Material Used:	22%	29%	17%	11%			20%	1%	100%	Design
Material Type:	1/2" Rock	Crusher Fines	Crushed Squeegee	Washed Sand			Crushed RAP	Hydrated Lime	JMF	Control Points
Material Source:	Spec Agg	Spec Agg	Riverbend	Cottonwood			Metro	Pete Lien		
1-1/2" (37.5 mm)	100	100	100	100			100	100	100	
1" (25.0 mm)	100	100	100	100			100	100	100	
3/4" (19.0 mm)	100	100	100	100			100	100	100	100
1/2" (12.5 mm)	89	100	100	100			94	100	96	90-100
3/8" (9.5 mm)	47	100	100	100			83	100	85	
#4 (4.75 mm)	5	78	88	100			63	100	63	
#8 (2.36 mm)	2	50	58	93			51	100	46	28-58
#16 (1.18 mm)	2	36	34	71			42	100	34	
#30 (600 µm)	2	28	20	44			30	100	24	
#50 (300 µm)	2	21	11	20			21	100	16	
#100 (150 µm)	2	15	6	6			13	100	10	
#200 (75 µm)	1.3	9.9	3.5	1.8			7.3	98.0	6.4	2.0-10.0
Bulk Specific Gravity	2.700	2.698	2.555	2.586			2.697	2.380	2.657	
App. Specific Gravity	2.766	2.780	2.622	2.667			2.697	2.380	2.715	
Percent Asphalt in Recycled Material							4.00			



HOT MIX ASPHALT MIX DESIGN PHYSICAL PROPERTIES

Client:	Metro Asphalt	
Mix Grading:	1/2" NMAS	
Aggregate Source:	Spec Agg/Riverbend/Cottonwood/RAP	
Asphalt Cement Source:	HollyFrontier	
Asphalt Cement Grade:	PG 64-22	Asphalt Cement Specific Gravity: 1.026
Additive Type:	Lime	
Compaction Method:	Superpave 75 Gyration	
Lab Temperature Mixing (°F) =	325	Lab Compaction (°F) = 300

Asphalt Content (%AC):	4.8	5.3	5.8	6.3
Bulk Specific Gravity (Gmb):	2.367	2.385	2.400	2.411
Max. Specific Gravity (Gmm):	2.508	2.489	2.470	2.452
Theoretical Max Unit Wt. (pcf):	156.5	155.3	154.1	153.0
Air Voids @ N-Design (%Va):	5.6	4.2	2.8	1.7
Voids in Mineral Aggregate (%VMA):	15.2	15.0	14.9	15.0
Voids Filled with Asphalt (%VFA):	63.0	72.1	81.0	88.8
Dust to Asphalt Ratio (D/A):	1.3	1.2	1.0	0.9
Hveem Stability:	40	42	39	37

Properties at Optimum

Specifications

Asphalt Content (%AC):	5.40	
Bulk Specific Gravity (Gmb):	2.388	
Max. Specific Gravity (Gmm):	2.484	
Theoretical Max Unit Wt. (pcf):	155.0	
Air Voids @ N-Design (%Va):	3.9	3.5 to 4.5
Voids in Mineral Aggregate (%VMA):	15.0	14.7 min. @ 3.9 voids
Voids Filled with Asphalt (%VFA):	74.2	65-75
Dust to Asphalt Ratio (D/A):	1.12	0.6-1.2
Hveem Stability:	41	30 min.

Effect of Moisture on Hot Mix Asphalt

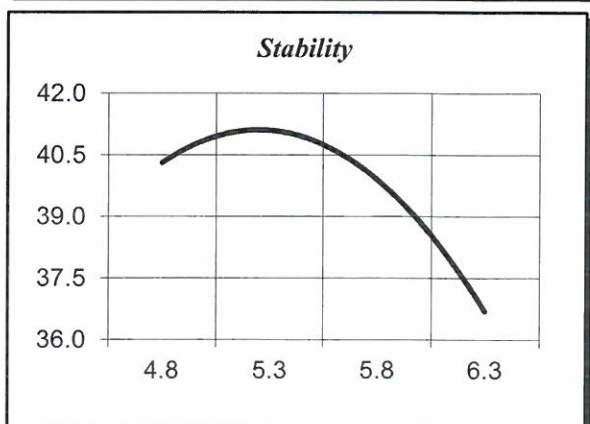
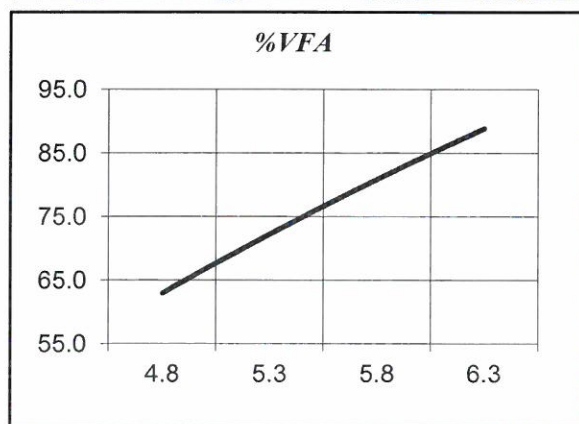
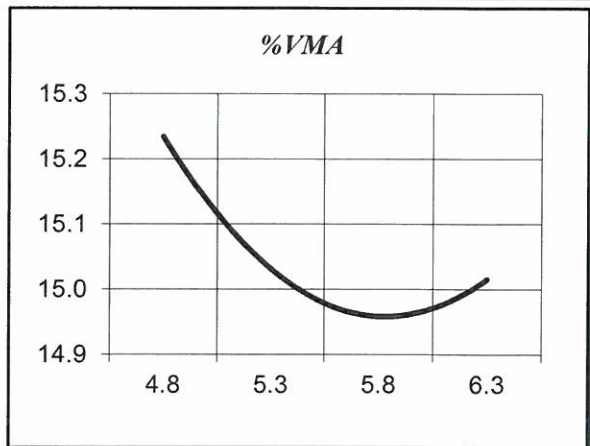
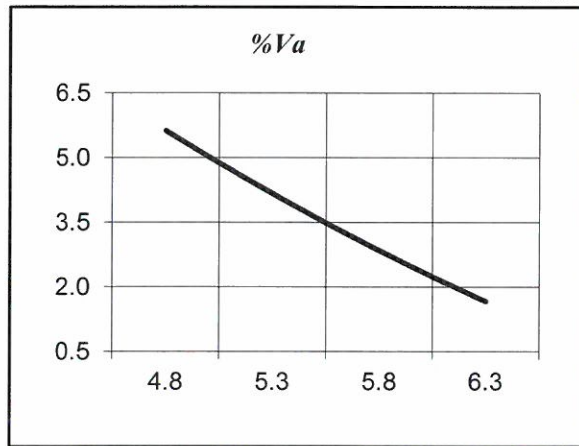
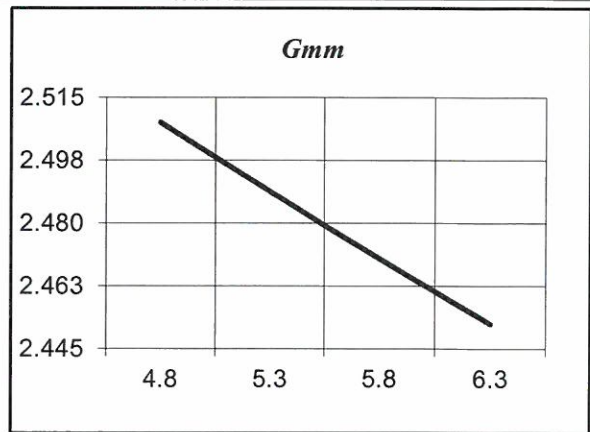
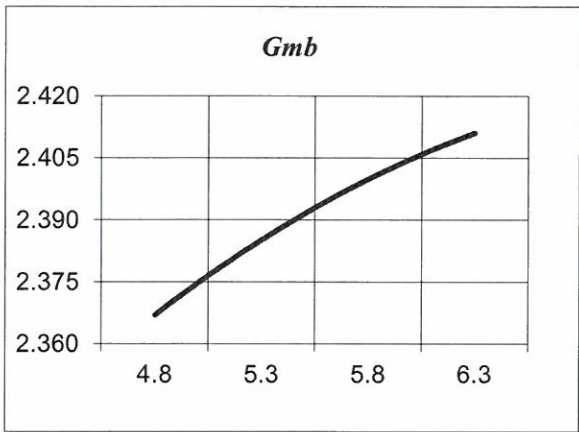
Method:	CDOT (CP-L 5109)	
Asphalt Content (%):	5.40	
Additive Type:	Lime	
Air Voids (%):	6.8	6 to 8
Saturation (%):	89.6	
Indirect Tensile Strength (Wet) (psi):	91	
Indirect Tensile Strength (Dry) (psi):	93	30 min.
Tensile Strength Ratio (%):	98	80 min.

Optimum properties are based on a best fit curve of all data points.

TEST PROPERTY CURVES

Client: Metro Asphalt
Grading: 1/2" NMA
Agg Source: Spec Agg/Riverbend/Cottonwood/RAP

Asphalt Content (%AC): 5.40
Bulk Specific Gravity (Gmb): 2.388
Max. Specific Gravity (Gmm): 2.484
Theoretical Max Unit Wt. (pcf): 155.0
Air Voids @ N-Design (%Va): 3.9
Voids in Mineral Aggregate (%VMA): 15.0
Voids Filled with Asphalt (%VFA): 74.2
Hveem Stability: 41.0



AGGREGATE PHYSICAL PROPERTIES
(does not include Lime or RAP)

Client: Metro Asphalt
Aggregate Source: Spec Agg/Riverbend/Cottonwood/RAP
Grading: 1/2" NMAS

		Combined Blend	Specifications
<i>Bulk Specific Gravity (Agg):</i>	<i>CDOT (CP-L 4102 & 4103)</i>	2.652	
<i>Apparent Specific Gravity (Agg):</i>		2.726	
<i>Bulk Specific Gravity Plus #4 (Agg):</i>		2.689	
<i>Bulk Specific Gravity Minus #4 (Agg):</i>		2.630	
<i>Combined Blend Absorption (Agg):</i>		1.03	
<i>L.A. Abrasion Plus #4 Material (%):</i>	<i>AASHTO (T 96)</i>	22	45 max.
<i>Sodium Sulfate Soundness (%):</i>	<i>AASHTO (T 88)</i>	7.4	12 max.
<i>Fractured Faces (2 or more) (%):</i>	<i>CDOT (CP 45)</i>	92	80 min.
<i>Fine Aggregate Angularity, Method A:</i>	<i>CDOT (CP-L 5113)</i>	45	45 min.
<i>Plasticity Index:</i>	<i>AASHTO (T 90)</i>	NP	Non-plastic
<i>Sand Equivalent:</i>	<i>ASTM (D 2419)</i>	71	45 min.
<i>Flat and Elongated Particles (%):</i>	<i>CDOT (CP 33)</i>	6.1	10 max.
<i>Adherent Fines (%):</i>	<i>ASTM (D 5711)</i>	0.36	0.5 max.
<i>Micro-Deval (%):</i>	<i>CDOT (CP-L 4211)</i>	12.3	18% max.