



3/7/2014

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

Attn: Mr. Pat Hartshorn

Re: Hot Mix Asphalt Mix Design  
Grading: 3/4" NMAS  
Method/Type: Superpave 75 Gyration  
Aggregate: Spec Agg/Riverbend/Cottonwood/RAP  
Plant Number(s): 16318, 16321  
Mix Design Number: 2243  
Product Number: 5493  
Ticket Description: (3/4)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.

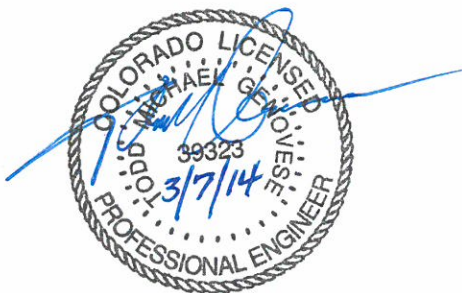
Properties of this mixture are:

Asphalt Content (%AC):	5.00	
Max. Theoretical Specific Gravity (Gmm):	2.499	(155.9 pcf)
Air Voids (%Va):	4.0	
Voids in Mineral Aggregate (%VMA):	14.4	
Voids Filled with Asphalt (%VFA):	72.5	
Tensile Strength Ratio, TSR (%):	95	
Hveem Stability:	44	

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

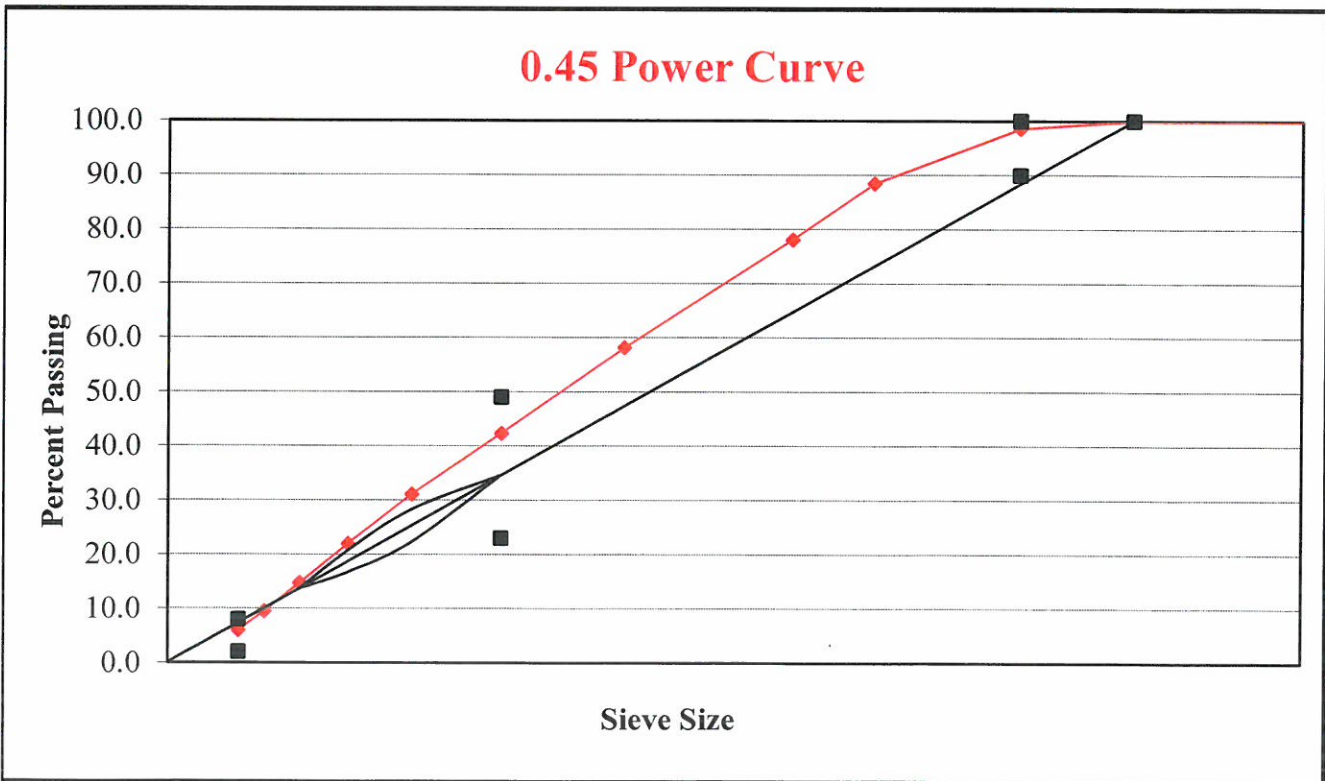
# Martin Marietta Materials



**Date:** 3/7/2014  
**Design Number:** 2243  
**Grading:** 3/4" 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:	15%	13%	26%	16%	9%		20%	1%	100%	Design
Material Type:	57/67 Rock	1/2" Rock	Crusher Fines	Crushed Squeegee	Washed Sand		Crushed RAP	Hydrated Lime	JMF	Control Points
Material Source:	Spec Agg	Spec Agg	Spec Agg	Riverbend	Cottonwood		Metro	Pete Lien		
1-1/2" (37.5 mm)	100	100	100	100	100		100	100	100	
1" (25.0 mm)	100	100	100	100	100		100	100	100	100
3/4" (19.0 mm)	91	100	100	100	100		100	100	99	90-100
1/2" (12.5 mm)	41	89	100	100	100		94	100	89	
3/8" (9.5 mm)	23	47	100	100	100		83	100	78	
#4 (4.75 mm)	4	5	78	88	100		63	100	58	
#8 (2.36 mm)	2	2	50	58	93		51	100	42	23-49
#16 (1.18 mm)	2	2	36	34	71		42	100	31	
#30 (600 µm)	2	2	28	20	44		30	100	22	
#50 (300 µm)	2	2	21	11	20		21	100	15	
#100 (150 µm)	2	2	15	6	6		13	100	10	
#200 (75 µm)	1.2	1.3	9.9	3.5	1.8		7.3	98.0	6.1	2.0-8.0
Bulk Specific Gravity	2.716	2.700	2.698	2.555	2.586		2.697	2.380	2.663	
App. Specific Gravity	2.783	2.766	2.780	2.622	2.667		2.697	2.380	2.721	
Percent Asphalt in Recycled Material							4.00			



**HOT MIX ASPHALT MIX DESIGN PHYSICAL PROPERTIES**

**Client:** Metro Asphalt  
**Mix Grading:** 3/4" 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

<b>Asphalt Content (%AC):</b>	<b>4.3</b>	<b>4.8</b>	<b>5.3</b>	<b>5.8</b>
<b>Bulk Specific Gravity (Gmb):</b>	2.367	2.391	2.411	2.422
<b>Max. Specific Gravity (Gmm):</b>	2.526	2.507	2.488	2.470
<b>Theoretical Max Unit Wt. (pcf):</b>	157.6	156.4	155.3	154.1
<b>Air Voids @ N-Design (%Va):</b>	6.3	4.6	3.1	1.9
<b>Voids in Mineral Aggregate (%VMA):</b>	14.9	14.5	14.3	14.3
<b>Voids Filled with Asphalt (%VFA):</b>	57.9	68.1	78.3	86.4
<b>Dust to Asphalt Ratio (D/A):</b>	1.4	1.2	1.1	1.0
<b>Hveem Stability:</b>	43	45	42	39

**Properties at Optimum**

**Specifications**

<b>Asphalt Content (%AC):</b>	<b>5.00</b>	
<b>Bulk Specific Gravity (Gmb):</b>	<b>2.400</b>	
<b>Max. Specific Gravity (Gmm):</b>	<b>2.499</b>	
<b>Theoretical Max Unit Wt. (pcf):</b>	<b>155.9</b>	
<b>Air Voids @ N-Design (%Va):</b>	<b>4.0</b>	<b>3.5 to 4.5</b>
<b>Voids in Mineral Aggregate (%VMA):</b>	<b>14.4</b>	<b>13.7 min. @ 4.0 voids</b>
<b>Voids Filled with Asphalt (%VFA):</b>	<b>72.5</b>	<b>65-75</b>
<b>Dust to Asphalt Ratio (D/A):</b>	<b>1.14</b>	<b>0.6-1.2</b>
<b>Hveem Stability:</b>	<b>44</b>	<b>30 min.</b>

**Effect of Moisture on Hot Mix Asphalt**

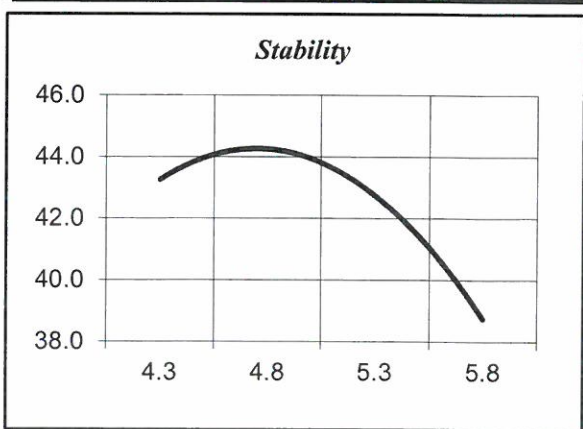
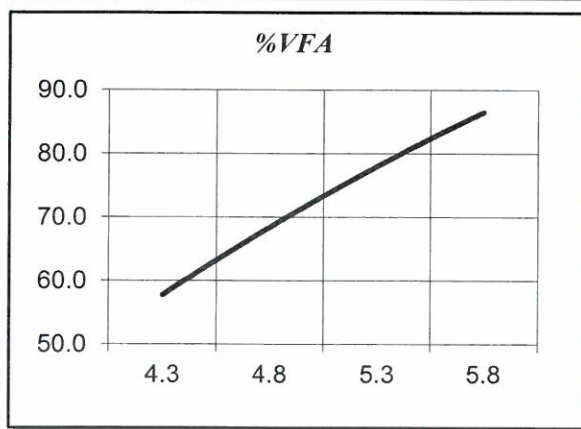
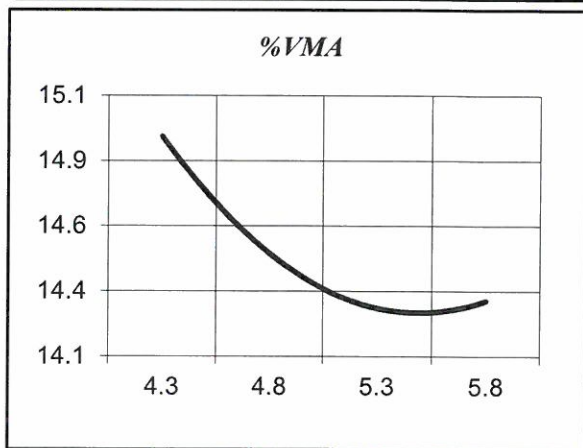
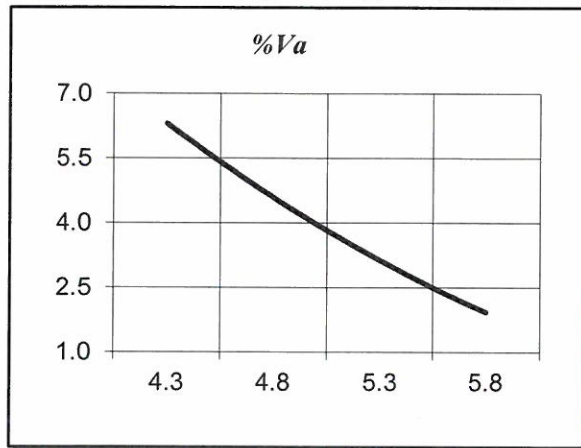
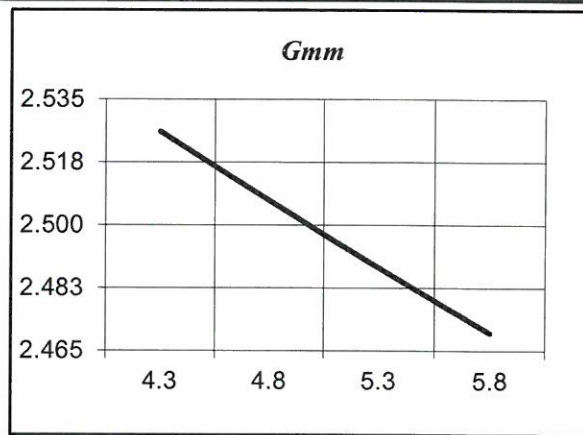
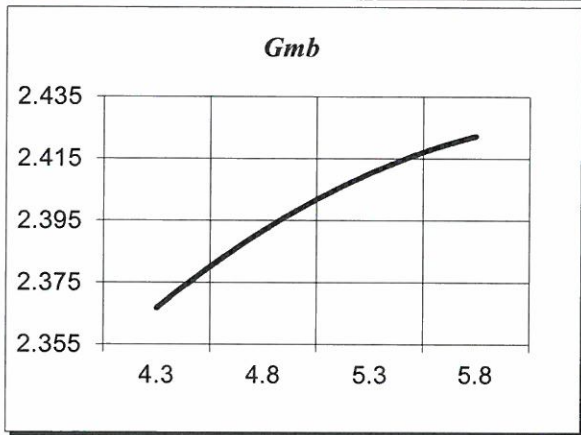
<b>Method:</b>	<b>CDOT (CP-L 5109)</b>	
<b>Asphalt Content (%):</b>	<b>5.00</b>	
<b>Additive Type:</b>	<b>Lime</b>	
<b>Air Voids (%):</b>	<b>6.9</b>	<b>6 to 8</b>
<b>Saturation (%):</b>	<b>91.4</b>	
<b>Indirect Tensile Strength (Wet) (psi):</b>	<b>87</b>	
<b>Indirect Tensile Strength (Dry) (psi):</b>	<b>92</b>	<b>30 min.</b>
<b>Tensile Strength Ratio (%):</b>	<b>95</b>	<b>80 min.</b>

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

**TEST PROPERTY CURVES**

**Client:** Metro Asphalt  
**Grading:** 3/4" NMA  
**Agg Source:** Spec Agg/Riverbend/Cottonwood/RAP

**Asphalt Content (%AC):** 5.00  
**Bulk Specific Gravity (Gmb):** 2.400  
**Max. Specific Gravity (Gmm):** 2.499  
**Theoretical Max Unit Wt. (pcf):** 155.9  
**Air Voids @ N-Design (%Va):** 4.0  
**Voids in Mineral Aggregate (%VMA):** 14.4  
**Voids Filled with Asphalt (%VFA):** 72.5  
**Hveem Stability:** 44.0



**AGGREGATE PHYSICAL PROPERTIES**  
*(does not include Lime or RAP)*

**Client:** Metro Asphalt  
**Aggregate Source:** Spec Agg/Riverbend/Cottonwood/RAP  
**Grading:** 3/4" NMAS

		<b>Combined Blend</b>	<b>Specifications</b>
<i>Bulk Specific Gravity (Agg):</i>	<i>CDOT (CP-L 4102 &amp; 4103)</i>	2.660	
<i>Apparent Specific Gravity (Agg):</i>		2.733	
<i>Bulk Specific Gravity Plus #4 (Agg):</i>		2.698	
<i>Bulk Specific Gravity Minus #4 (Agg):</i>		2.631	
<i>Combined Blend Absorption (Agg):</i>		1.01	
<i>L.A. Abrasion Plus #4 Material (%):</i>	<i>AASHTO (T 96)</i>	22	<i>45 max.</i>
<i>Sodium Sulfate Soundness (%):</i>	<i>AASHTO (T 88)</i>	6.6	<i>12 max.</i>
<i>Fractured Faces (2 or more) (%):</i>	<i>CDOT (CP 45)</i>	97	<i>80 min.</i>
<i>Fine Aggregate Angularity, Method A:</i>	<i>CDOT (CP-L 5113)</i>	47	<i>45 min.</i>
<i>Plasticity Index:</i>	<i>AASHTO (T 90)</i>	NP	<i>Non-plastic</i>
<i>Sand Equivalent:</i>	<i>ASTM (D 2419)</i>	61	<i>45 min.</i>
<i>Flat and Elongated Particles (%):</i>	<i>CDOT (CP 33)</i>	2.4	<i>10 max.</i>
<i>Adherent Fines (%):</i>	<i>ASTM (D 5711)</i>	0.28	<i>0.5 max.</i>
<i>Micro-Deval (%):</i>	<i>CDOT (CP-L 4211)</i>	10.3	<i>18% max.</i>