

Mix Design Summary - 2009

16th Annual Oregon Asphalt Conference

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Asphalt Pavement Association of Oregon

OVERVIEW

- Look at new 80 gyration mixes
- Look at Bailey Analysis
- Look at techniques to deal with high VMA mixes due to “Flat and Elongated” in the fine aggregate

2009 Ideal Targets

80 Gyration 1/2" Dense-Graded Mixes

These are the gradations targets that were recommended for the 2009 Construction season.

Sieve	%Passing
3/4"	100
1/2"	95
3/8"	82
1/4"	65
No. 4	55
No. 8	36
No. 16	26
No. 30	17
No. 50	12
No. 100	8
No. 200	6.0

80 Gyration Mixes

	P_b (Total Oil)	Passing No. 8 (Target = 36)	Passing No. 200 (Target = 6.0)	VMA (Target = 15)
2008 (14 Mixes)	6.02	36.0	6.52	15.33
2009 (36 Mixes)	5.98	36.9	6.39	15.39

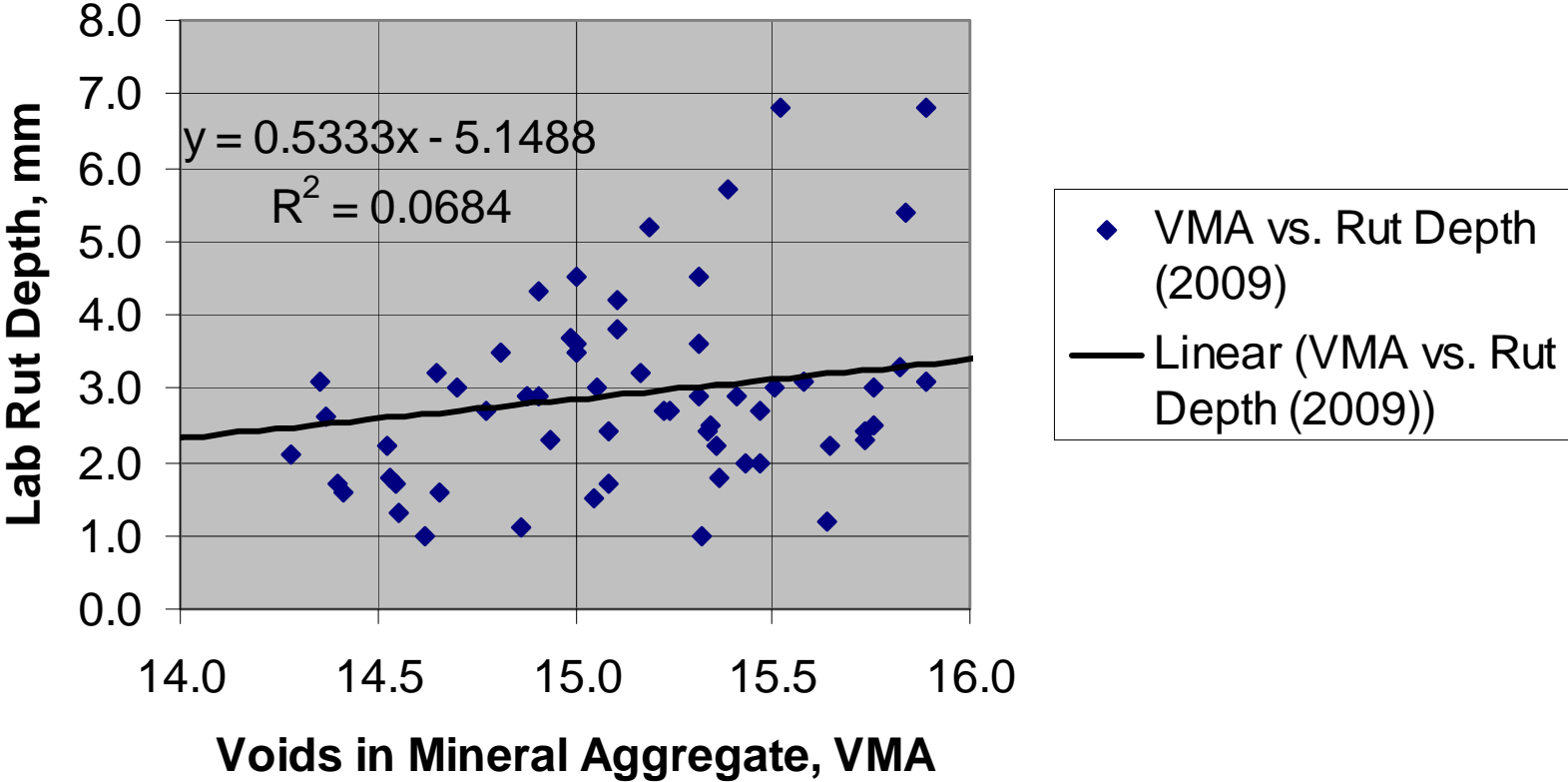
80 Gyration Mixes

(Typical Specification: Maximum Rut Depth = 6.0mm)

	Average VIR% (Non-Absorbed Oil)	Avg. Laboratory Rut Depth, mm
2006	12.89	2.46
2007	12.95	2.81
2008	13.16	2.90
2009	13.17	2.95

80 Gyration Mixes

VMA vs. Rut Depth



2010 Ideal Targets

80 Gyration 1/2" Dense-Graded Mixes

These are the gradations targets that are recommended for the 2010 Construction season.

The intent of the new targets is to bring the Average VMA down to 15.0%

Sieve	%Passing
3/4"	100
1/2"	95
3/8"	82
1/4"	66*
No. 4	56*
No. 8	38*
No. 16	26
No. 30	18*
No. 50	12
No. 100	8
No. 200	5.7*

Bailey Analysis

Coarse Aggregate (CA) Ratio

Divide the coarse aggregate into two parts:

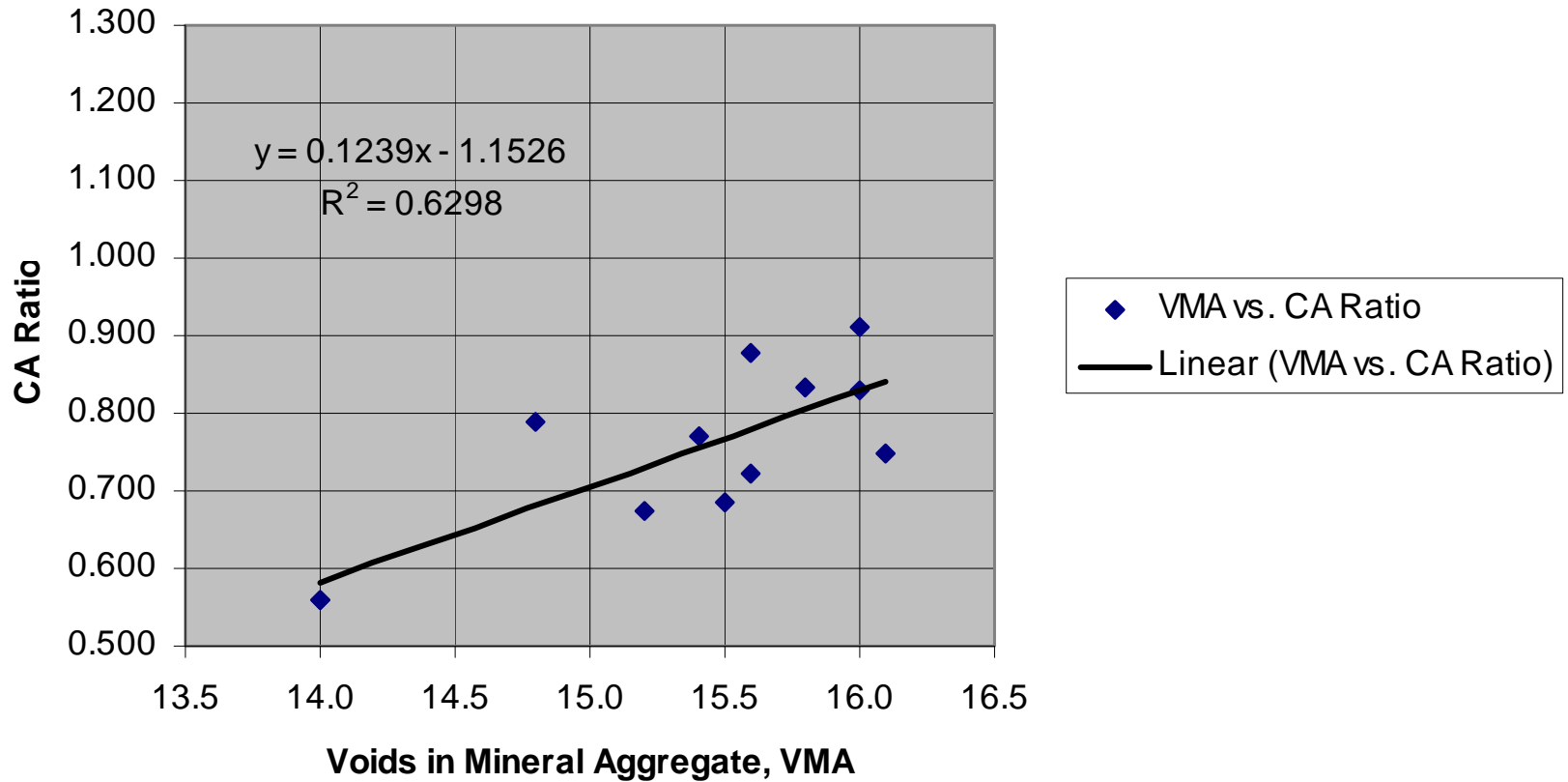
- Fine Portion of the Coarse Aggregate
- Coarse Portion of the Coarse Aggregate

The Ratio of Fine to Coarse should fall within:

0.65 - 1.00

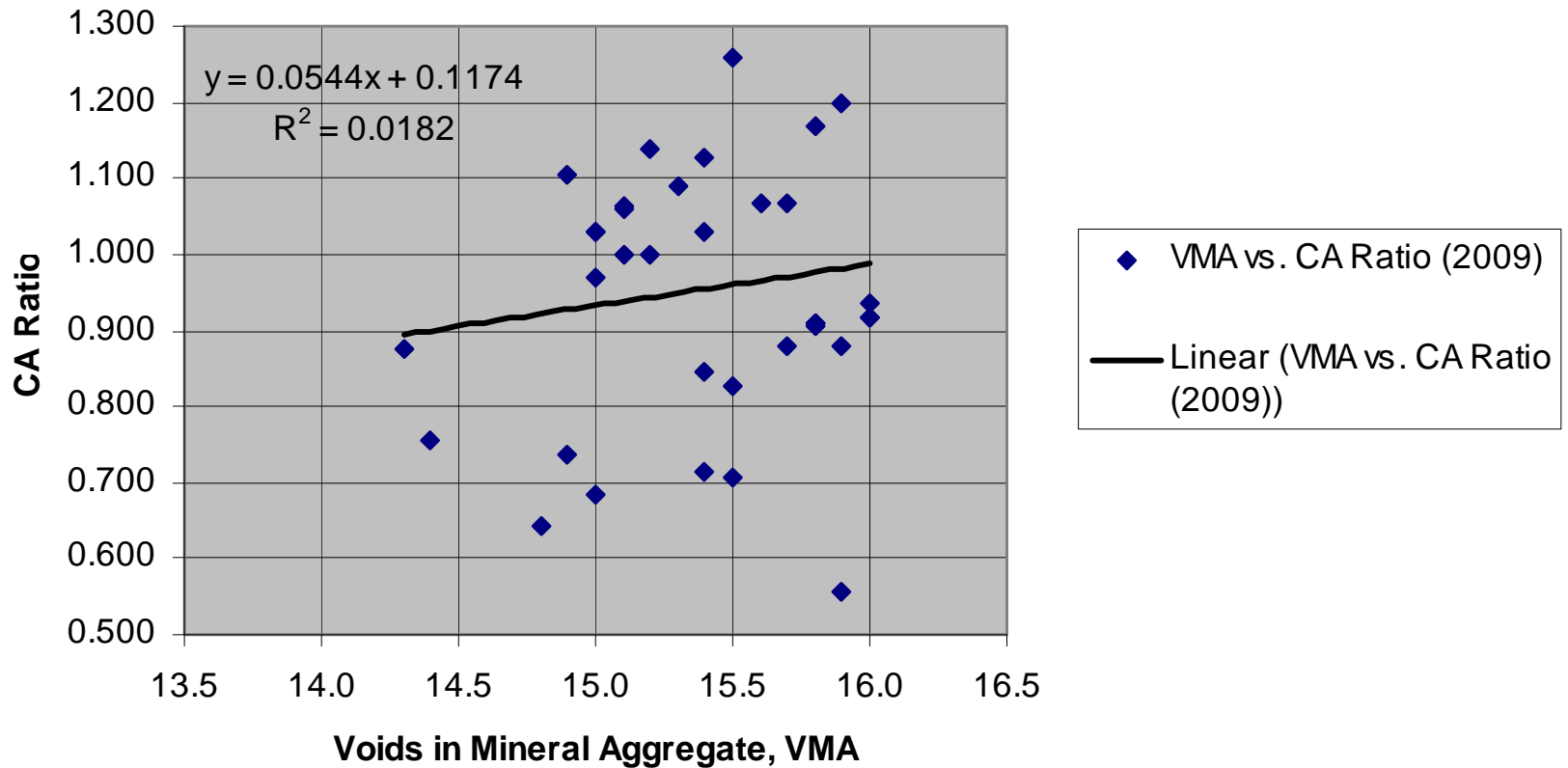
Bailey Analysis

VMA vs. CA Ratio (2008)



Bailey Analysis

VMA vs. CA Ratio (2009)



Bailey Analysis

CA Ratio Criteria: (0.65 to 1.00)

(Desired Value = 0.825 for 80 gyration mixes)

Year	Average CA Ratio 80 Gyration Mixes
2008 (14 Mixes)	0.747
2009 (36 Mixes)	0.954

Bailey Analysis

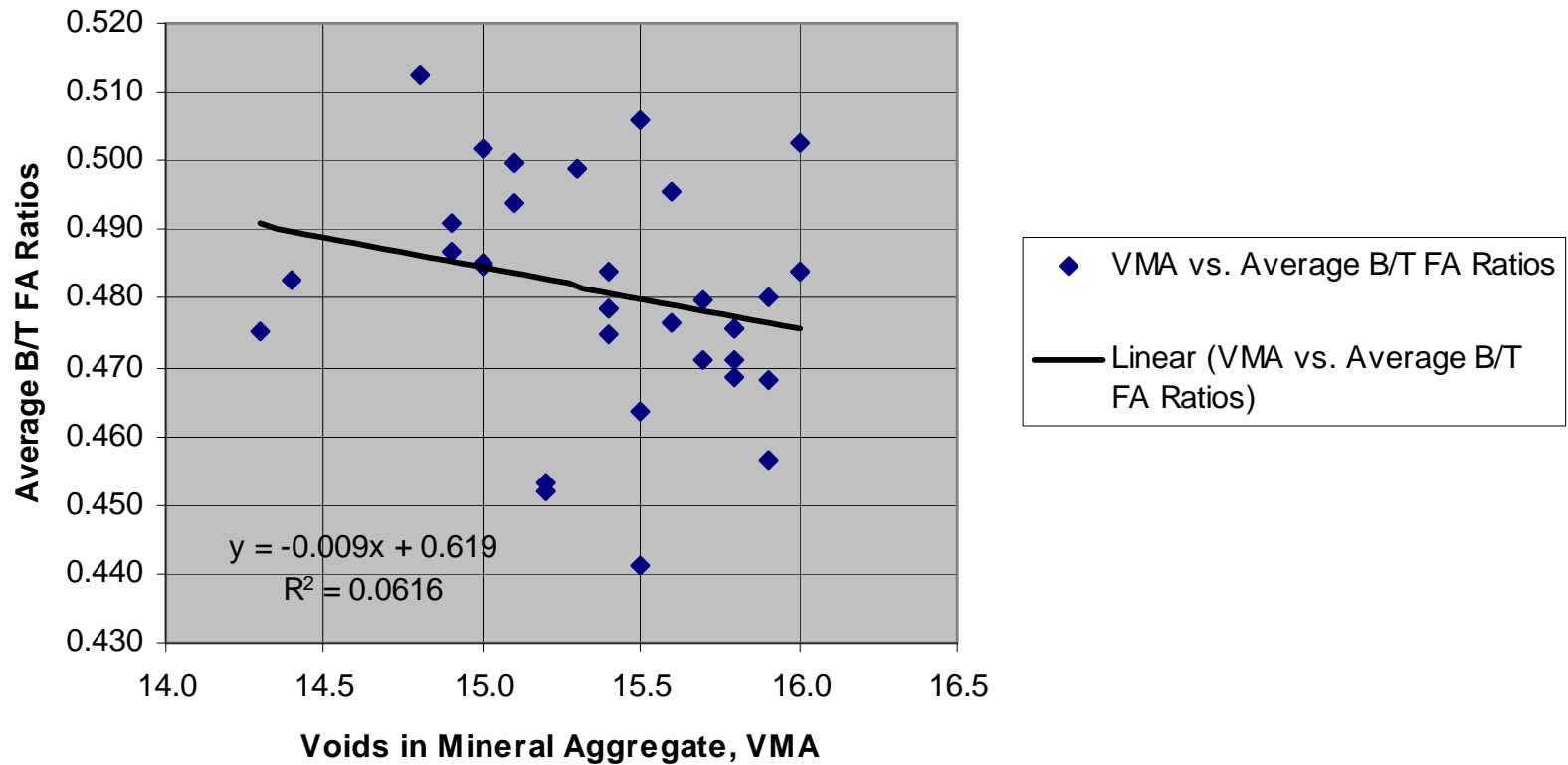
B/T Fine Aggregate (FA) Ratios

Sieve	Ratio
No. 8	$\text{No. 8} \div 3/8''$
No. 16*	$\text{No. 16} \div \text{No. 4}$
No. 30	$\text{No. 30} \div \text{No. 8}$
No. 50*	$\text{No. 50} \div \text{No. 16}$
No. 100*	$\text{No. 100} \div \text{No. 30}$
No. 200	$\text{No. 200} \div \text{No. 50}$

B/T FA Ratios should
fall within:
(0.35 to 0.50)

Bailey Analysis

VMA vs. Average B/T FA Ratios



Bailey Analysis

B/T FA Ratio Criteria: (0.35 to 0.50)

(Most Oregon Mixes are 0.450+)

Year	Average B/T FA Ratios 80 Gyration Mixes
2009 (36 Mixes)	0.481

2010 Ideal Targets

80 Gyration 1/2" Dense-Graded Mixes

	Bailey CA Ratio (0.65 to 1.00)
1/2" Dense-Graded Mix	0.824
Sieve	B/T FA Ratios (0.35 to 0.50)
No. 8	0.463
No. 16	0.464
No. 30	0.474
No. 50	0.462
No. 100	0.472
No. 200	0.475
Average:	0.468

High VMA Mixes

Flat and Elongated Material in the Fines

- Associated with Quarries
- B/T Ratios don't work...
- ODOT TM 229 only measures F&E down to the No. 4 size material
- As we have moved to finer mixes (1/2" Dense) particle shape in the -No. 4 sizes is having a greater impact on VMA

High VMA Mixes

Flat and Elongated Material in the Fines

- In several cases, the problem was mitigated by increasing the Passing No. 200 ($\approx + 1.0 - 1.5\%$)
- The normal rule of thumb for managing VMA with PNo. 200 is 1:1.
- With mixes that had high F&E in the fines we saw VMA reduced as much as 2:1 with PNo. 200.

High VMA Mixes

Flat and Elongated Material in the Fines

- AASHTO T 304 - Fine Aggregate Angularity Test



High VMA Mixes

Flat and Elongated Material in the Fines

- Fine Aggregate allowed to free fall from a fixed height into a container of known volume.



High VMA Mixes

Flat and Elongated Material in the Fines

- Strike off and determine the mass of material in the container.
- Using Specific Gravity of the material a calculation is made to determine the FAA



High VMA Mixes

Flat and Elongated Material in the Fines

- **Fine Aggregate Angularity (FAA):**
 - The lower the number, rounder the material (Unwashed Blend Sand $\approx 40 - 43$)
 - The higher the number, the more angular the material (Typical HMA $\approx 45 - 50$)
 - Extreme Flaky HMA material: 50+

Report No. K-TRAN: KU-98-5
Final Report

EFFECTS OF AGGREGATE ANGULARITY ON VMA AND RUTTING OF KDOT SUPERPAVE LEVEL 1 MIXES

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May 2001

K-TRAN

A COOPERATIVE TRANSPORTATION RESEARCH PROGRAM BETWEEN:
KANSAS DEPARTMENT OF TRANSPORTATION
KANSAS STATE UNIVERSITY
THE UNIVERSITY OF KANSAS

REPRODUCED BY:
U.S. Department of Commerce
National Technical Information Service
Springfield, Virginia 22161

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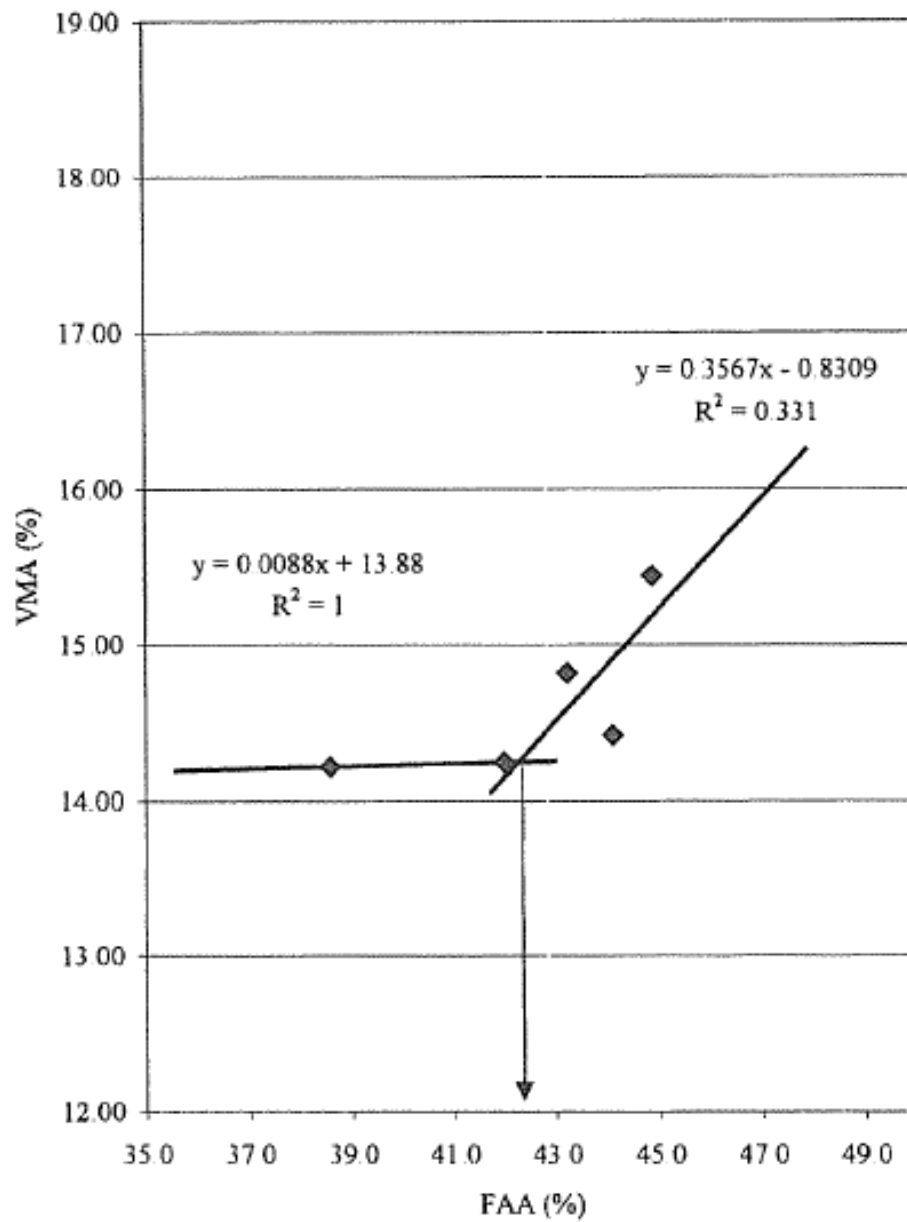


FIGURE 6 VMA vs. FAA for SM-1B Gradation

Kansas DOT

- If the FAA's of the individual stockpiles are known, then by weighted average you can accurately predict the FAA of the JMF blend.

$$\text{JMF Blend FAA} = CF_1 \times FAA_1 + CF_2 \times FAA_2 + \dots$$

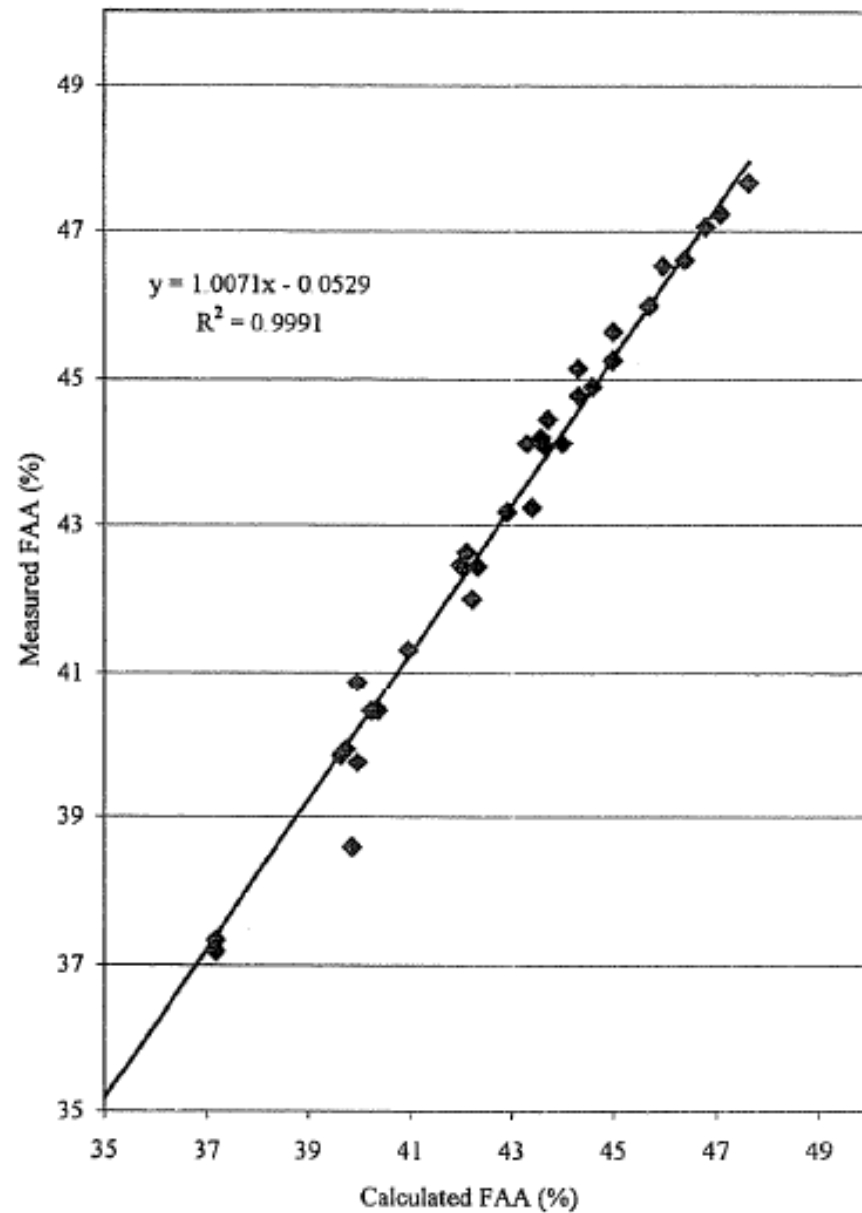


FIGURE 5 Comparison of Measured to Calculated FAA Values

High VMA Mixes

Flat and Elongated Material in the Fines

- APAO will measure the FAA on JMF Blends this season to develop a FAA vs. VMA curve for Oregon aggregates.
- We recommend that producers that struggle with high VMA mixes acquire the test apparatus and begin monitoring FAA on their stockpiles.

High VMA Mixes

Flat and Elongated Material in the Fines

APAO:

- Make our findings available as soon as possible
- Develop guidelines for mitigating materials with high FAA.

