Optimizing Laboratory Design for Five Percent Superpave (Superpave5)

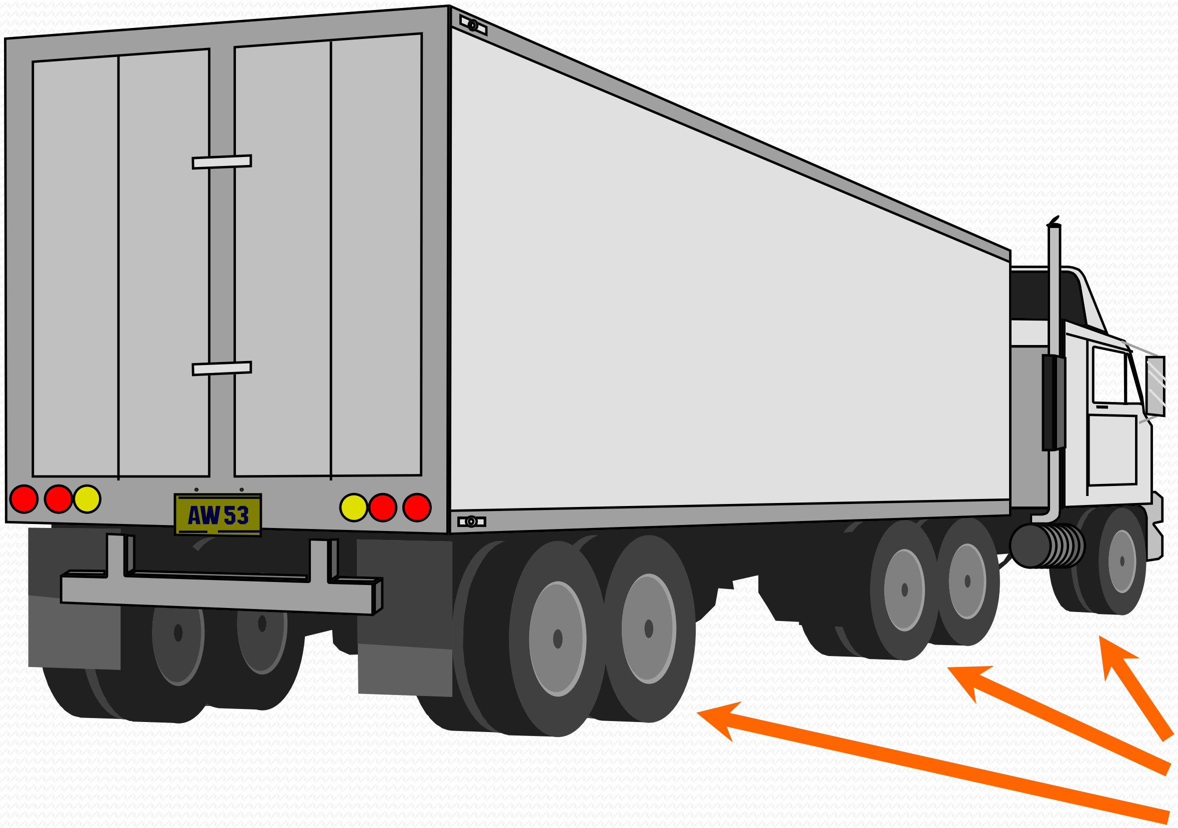
History of Design Air Voids

- Marshall Mix Design
  - Set up in late 1940s
  - Design voids set at 3 to 5%
- Marshall Mix Compaction
  - “Standard” rolling train
    - Static Steel Wheel
    - Pneumatic tired
  - 8% will densify under traffic to 4%
    - “Density at end of life = Design Density”

Superpave Mix Design

- "Marshall" concept carried forward
  - Design air voids fixed at 4%
- Recommended compaction
  - Set at 92% Gmm

DENSITY AT END OF LIFE??



Compaction
Caused by this

Typical As Constructed Density

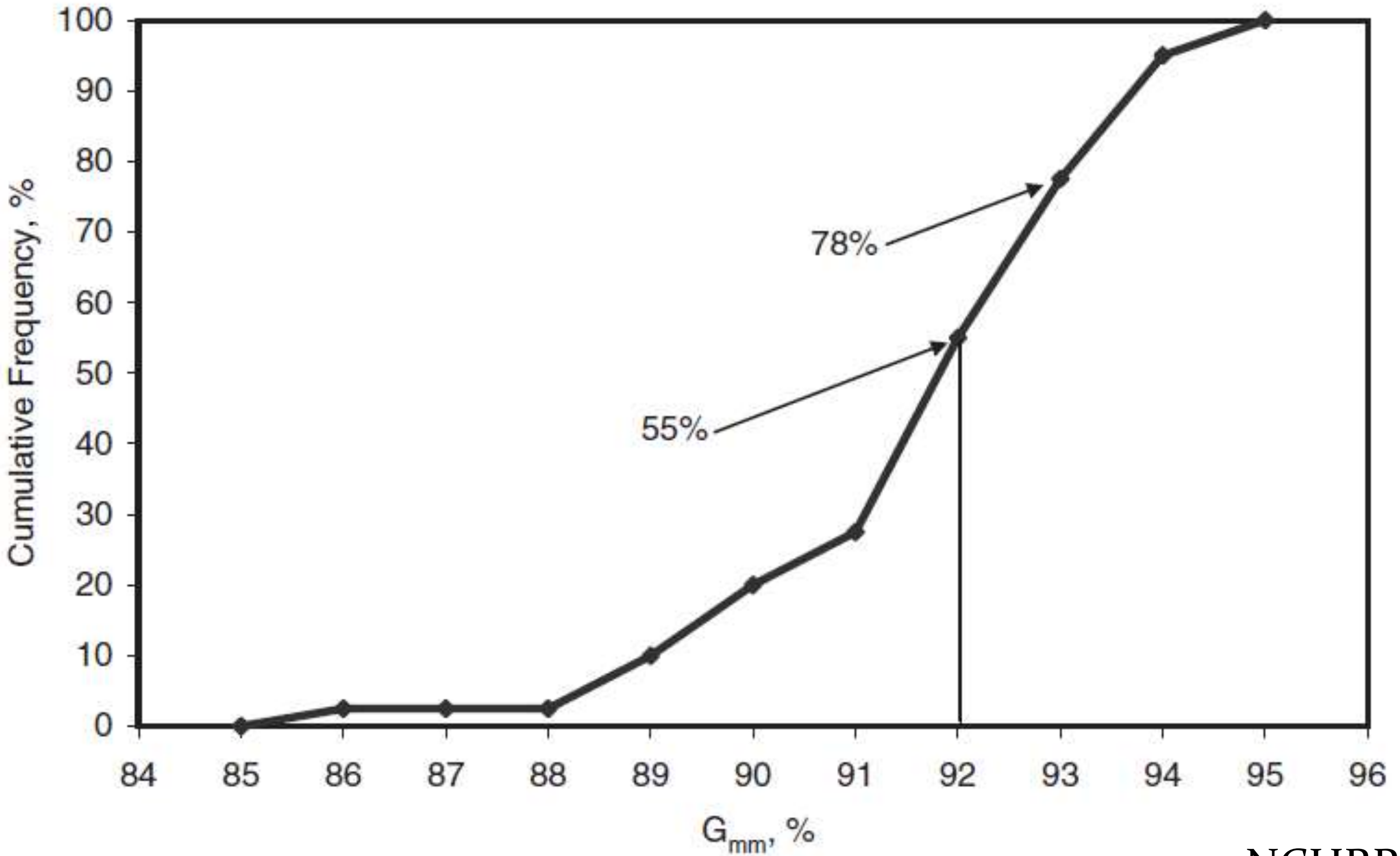


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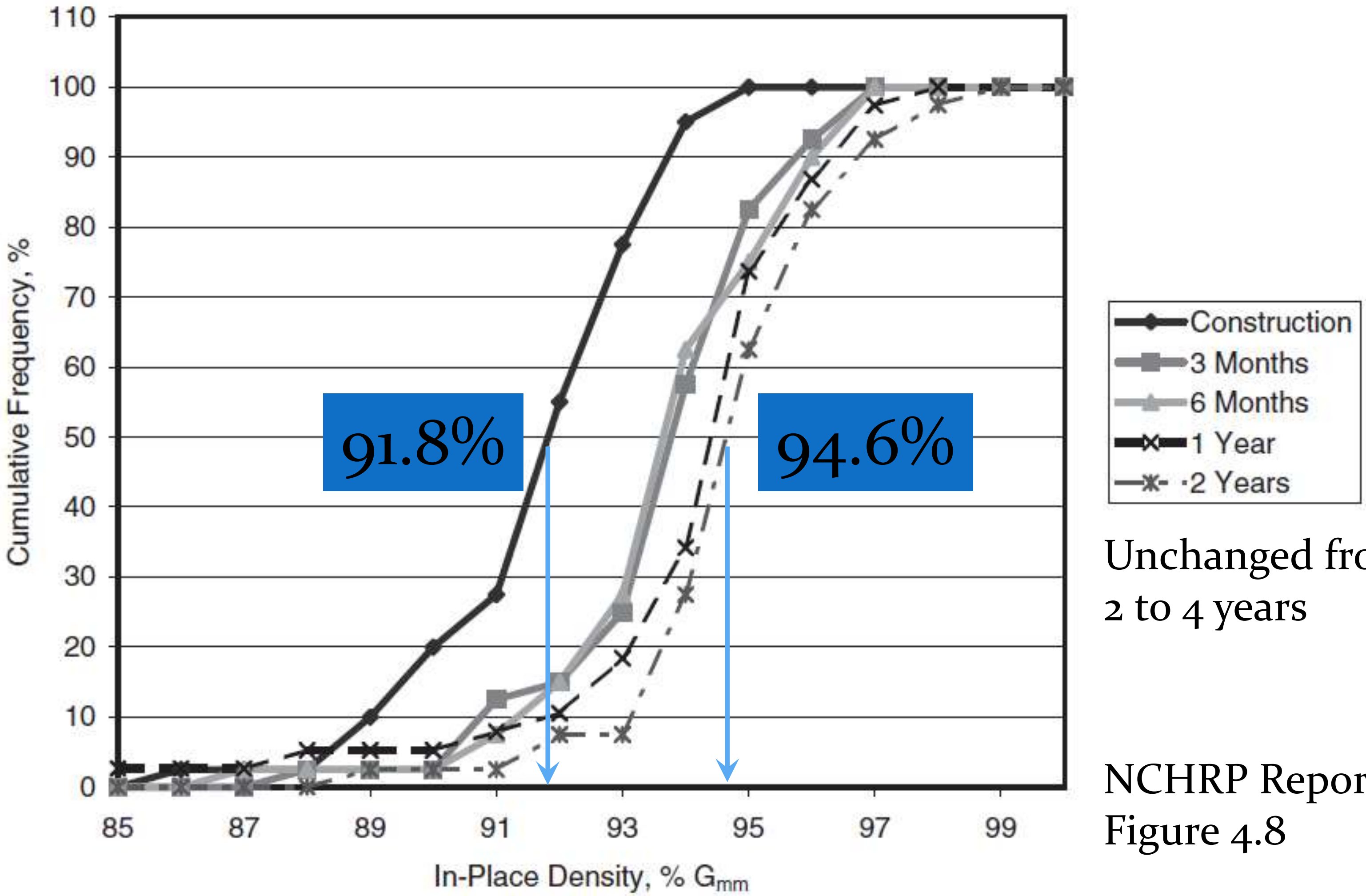
Figure 4.6

Typical "Final" Density



Unchanged from 2 to 4 years

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Figure 4.8

Superpave 5 Concept

- Mix Design 5% air voids
- Field Compaction 95% Gmm

- Higher design air voids
  - 5% instead of 4%
- No change in asphalt content

- Improve Durability
  - Lower air voids in the field

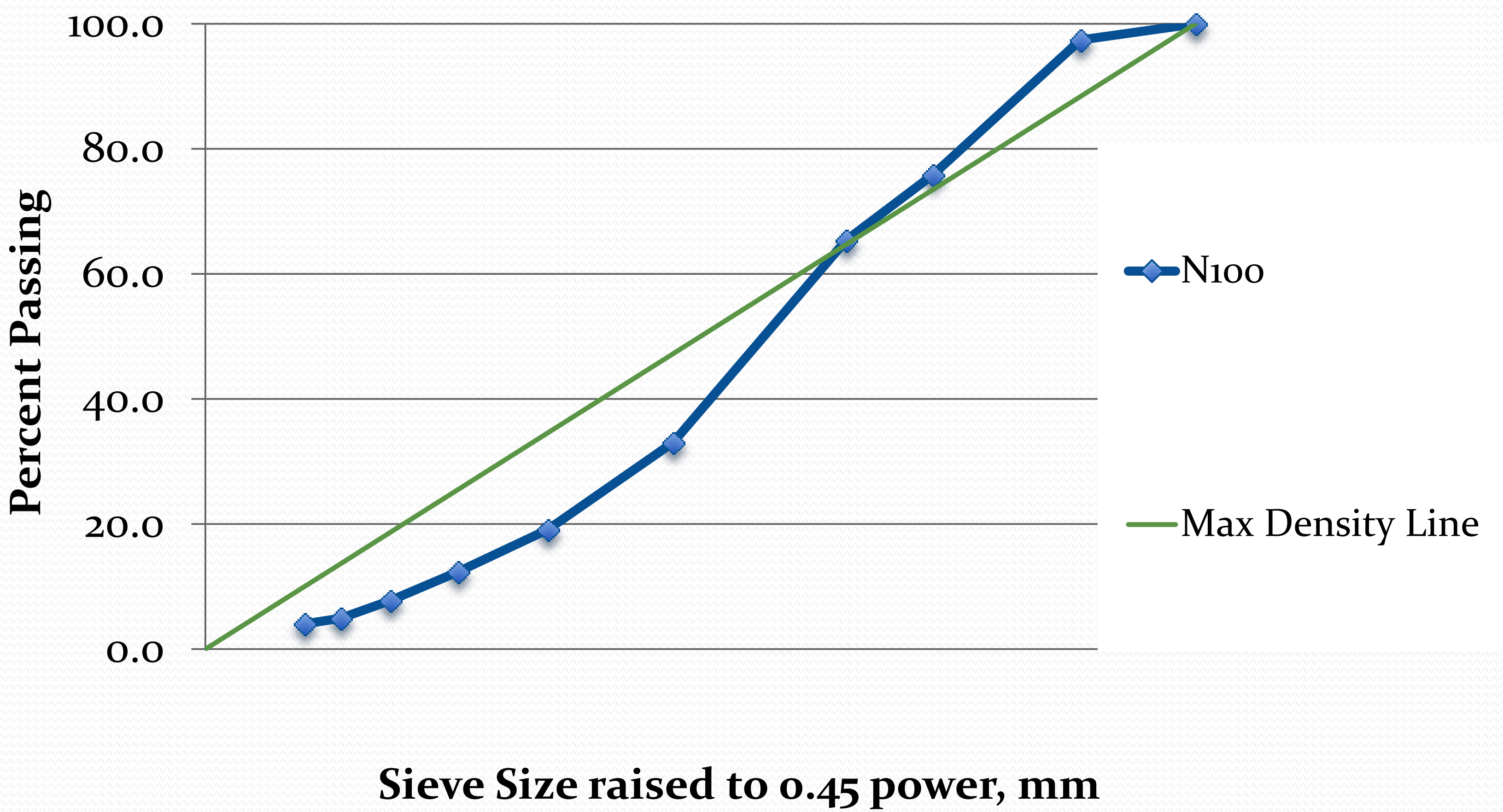
Purdue Experiment

- Three mix designs
  - 9.5-mm (3-10 million)
  - 9.5-mm (10-30 million)
  - 19.0-mm (10-30 million)

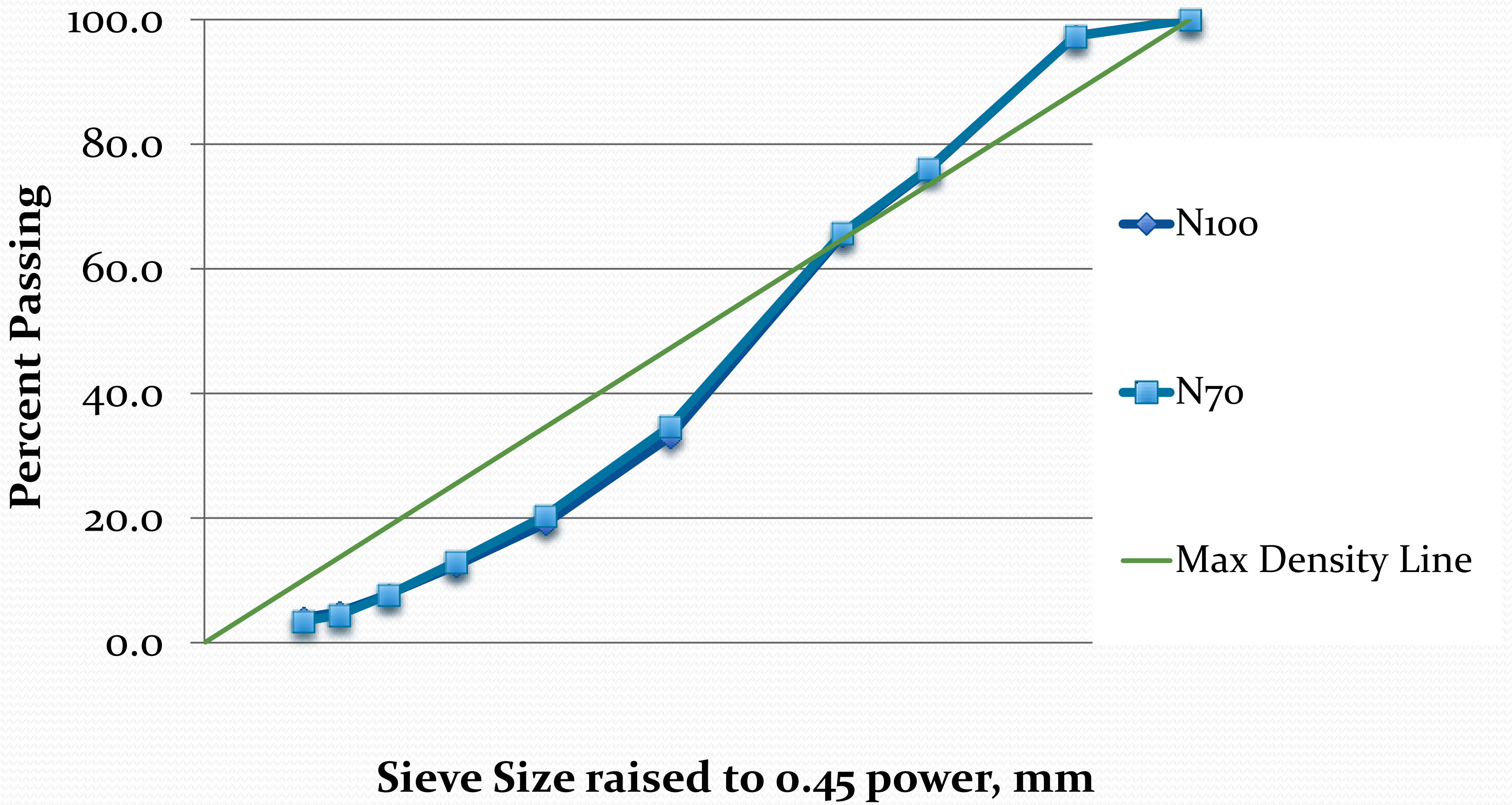
9.5-mm Mixture Design

	Trial Number			
	N100/4	N70/5	N50/5	N30/5
P_b, %	5.9	5.9	6.0	6.0
P_{be}, %	4.7	4.7	4.7	4.7
V_a, %	4.1	5.1	4.9	5.3
VMA, %	15.0	16.0	15.8	16.3
VFA, %	72.3	67.9	68.9	67.7

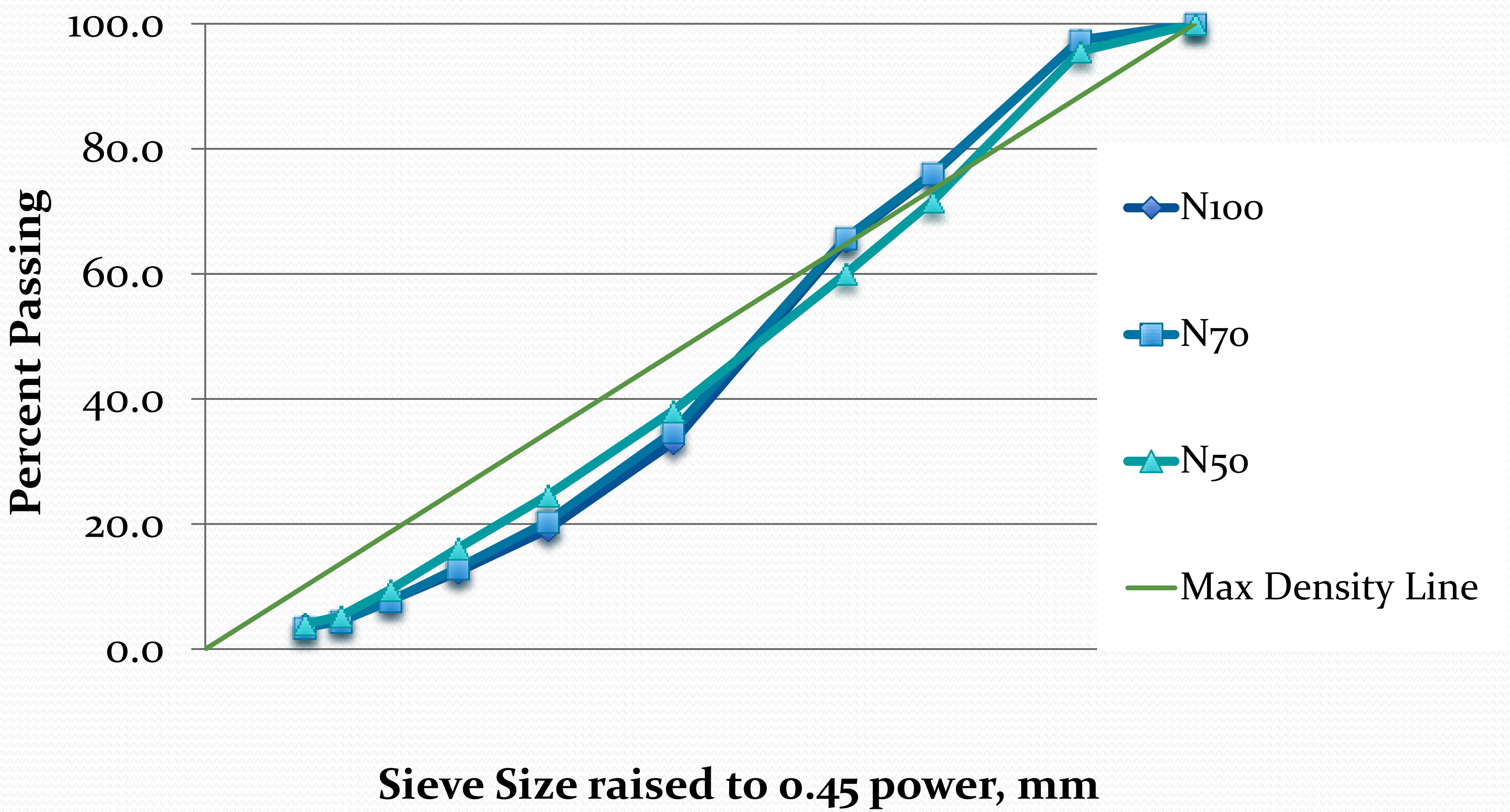
9.5-mm Mixture Gradations



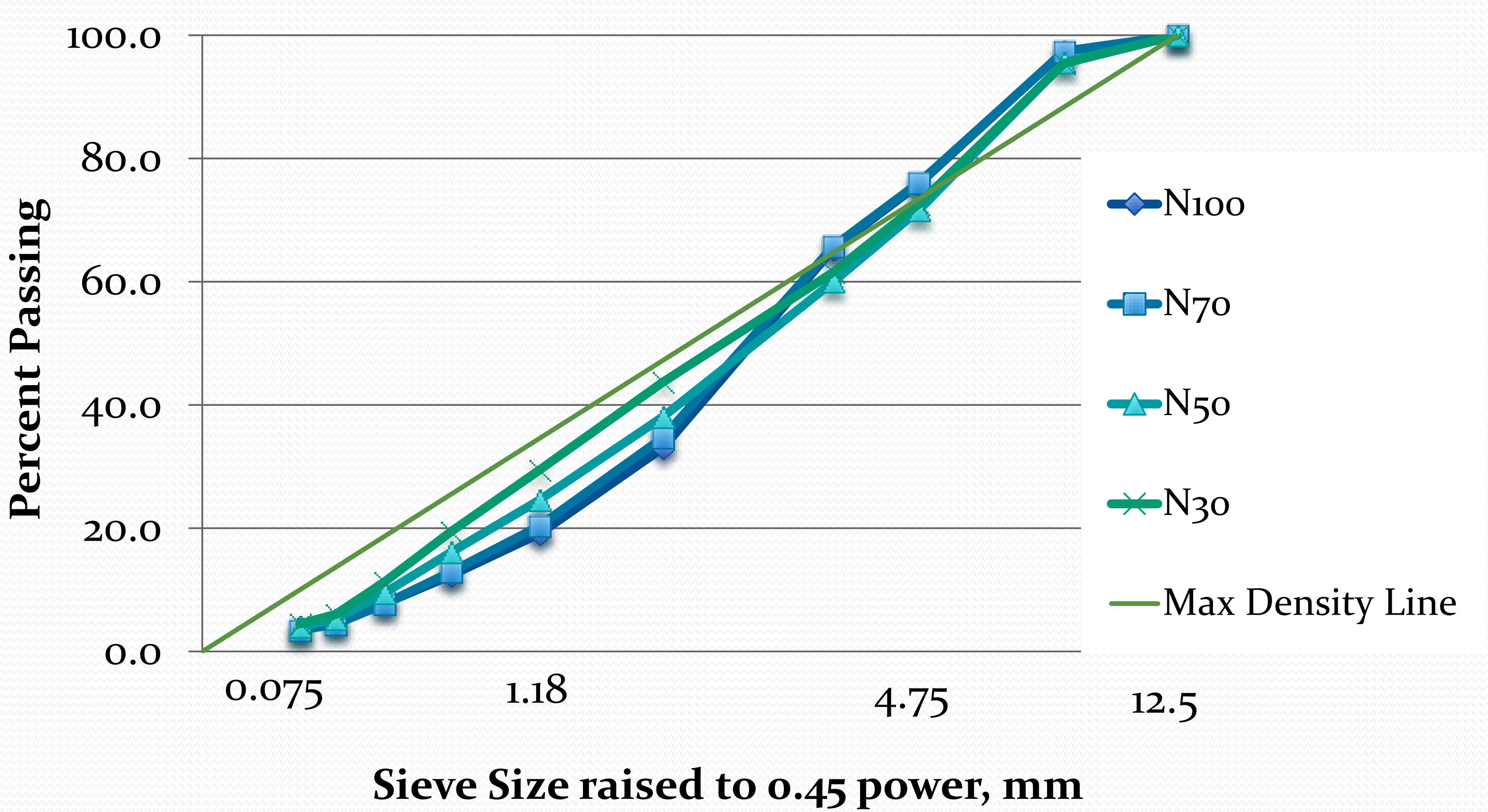
9.5-mm Mixture Gradations



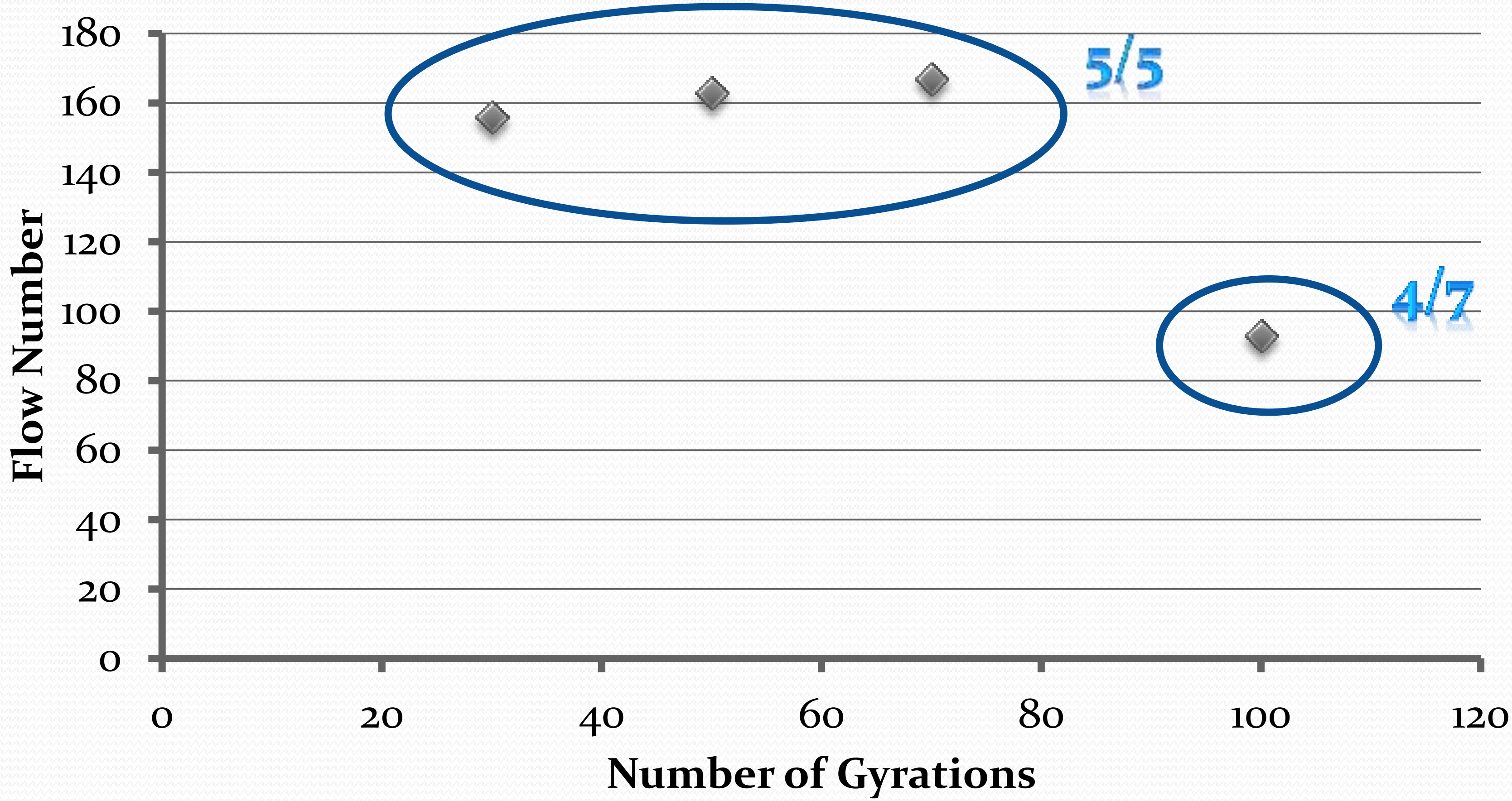
9.5-mm Mixture Gradations



9.5-mm Mixture Gradations



Rut Resistance Comparison



Laboratory Study Conclusions

- Designs at 5% Air Voids And 95% Gmm Compaction

30 gyrations

  - Equal or Greater
    - Stiffness
    - Flow Number

- Than designs at 4% Air Voids And 93% Gmm Compaction

100 gyrations

Superpave5 Field Trial

Georgetown Road

Georgetown Road

- Reconstruction and widening
- Trial Mix
  - 19 mm
  - 330 lb/yd2 (3 inches)

Paving Train

Paving Train


N30 (5% Air Void) Mix


N30 (5% Air Void) Mix


N30 (5% Air Void) Mix


Field Density Control


N30 (5% Air Void) Mix


Plate Sample from Road for QA

Gradation (Plate Sample)

	Superpave5 (20141213)			Superpave4 (20141212)	
	DMF	Sublot 1	Sublot 2	DMF	Sublot 1
25.0	100.0	100.0	100.0	100.0	100.0
19.0	95.2	97.9	97.7	95.3	98.2
12.5	80.5	84.5	91.4	82.1	86.3
9.5	68.8	73.8	82.5	73.0	76.2
4.75	42.1	48.0	54.7	47.0	51.6
2.36	30.1	33.7	37.9	32.6	35.3
1.18	20.6	22.8	25.5	20.8	22.6
0.600	14.5	15.9	17.6	13.9	15.3
0.300	9.5	10.4	11.2	9.4	10.0
0.150	6.8	7.1	7.8	6.9	7.0
0.075	5.8	5.3	6.0	5.7	5.4

QA Volumetric Properties

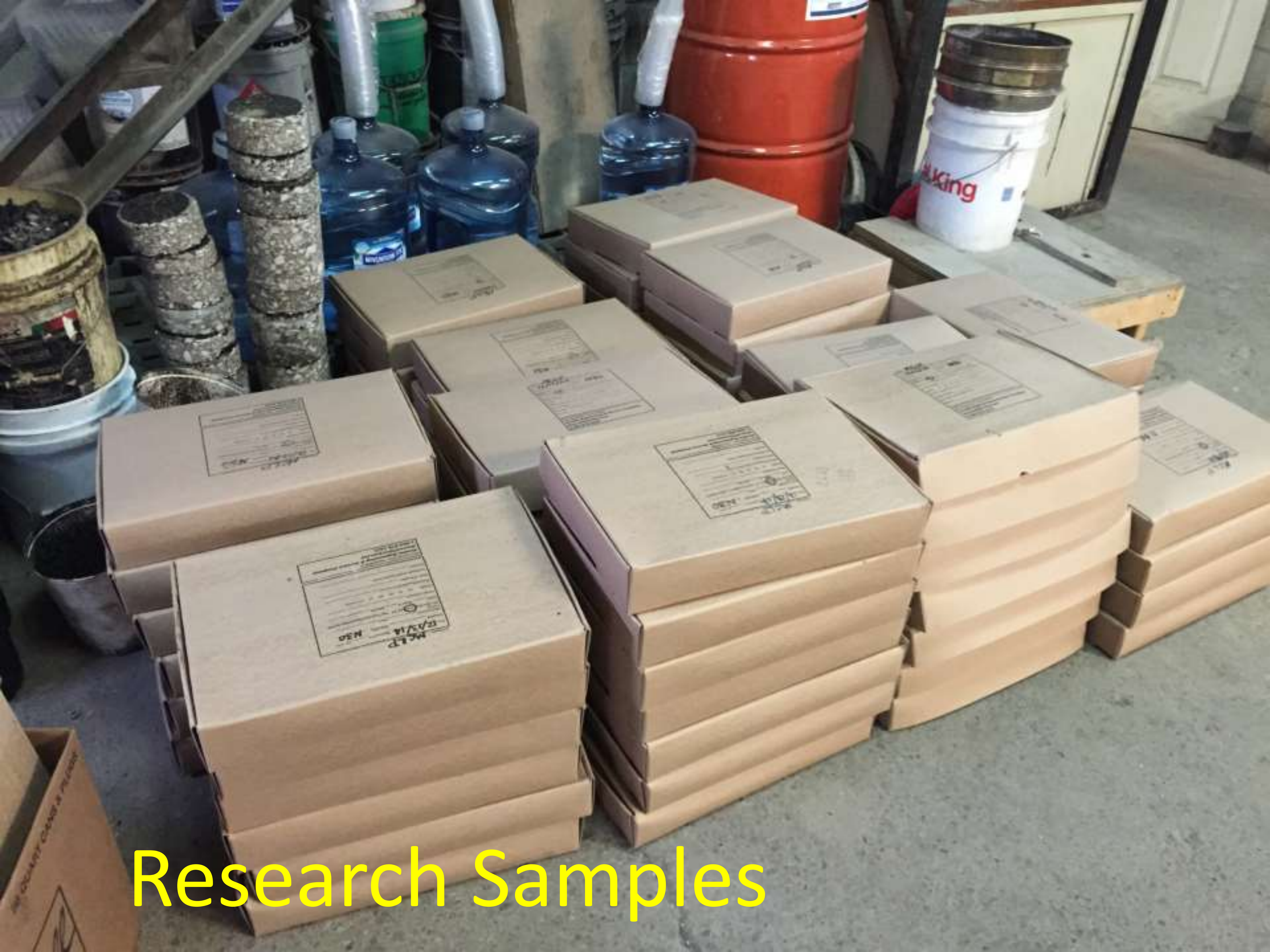
	Superpave5			Superpave4	
	DMF	Sublot 1	Sublot 2	DMF	Sublot 1
% Asphalt	4.8	4.44	4.76	4.6	4.68
Gmm		2.505	2.494		2.523
Gmb 1		2.366	2.368		2.411
Gmb 2		2.358	2.365		2.411
Air Voids 1	5.0	5.5	5.1	4.0	4.4
Air Voids 2	5.0	5.9	5.2	4.0	4.4
VMA 1	15.1	14.4	14.6	13.4	12.9
VMA 2	15.1	14.6	14.7	13.4	12.9

QA Core Density

	Superpave5			Superpave4	
	DMF	Sublot 1	Sublot 2	DMF	Sublot 1
Gmm		2.513	2.496		2.521
Core Gmb 1		2.423	2.360		2.352
Core Gmb 2		2.419	2.418		2.333
Ave % Gmm		96.3	95.7		92.9


Loose Research Samples


Research Cores



Research Samples

Testing

- Permeability
- Hamburg Rut Testing
  - Short term aged
  - Long Term Aged
- SCB
  - Short term aged
  - Long Term Aged

Next Step

- Superpave5 mix design set at 50 gyrations
  - Develop Trial Specification

- Let project(s) with Superpave5 specifications
  - Determine Acceptance Tolerances
    - Air voids
    - VMA
    - Density

Thank You

Greetings from Billy Bob