Illinois Asphalt Pavement Association
78th Annual Meeting

Optimizing Laboratory Design for Five Percent Superpave (Superpave5)

Matt Beeson
Indiana Department of Transportation

Acknowledgements

- Gerry Huber
  - Heritage Research Group
- Bill Pine
  - Heritage Construction and Materials
- John Haddock
  - Purdue University
- Ali Hekmatfar
  - Purdue University

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

Superpave5

Concept

- Design at 5% air voids
- Compact to 5% (95% Gmm)

- Increase VMA by 1%
- Increase air voids by 1%
  - 5% instead of 4%

- Aggregate specifications stay same
- Lift thickness stays same

Benefit

- Asphalt content stays same
- Higher in-place density
- Lower permeability
- Reduced aging (?)

- No(?) increase in cost

Asphalt Content Remains Same

	Superpave5			Superpave4		
NMAS	VMA	Air Voids	Vbe	VMA	Air Voids	Vbe
9.5	16.0	5.0	11.0	15.0	4.0	11.0
12.5	15.0	5.0	10.0	14.0	4.0	10.0
19.0	14.0	5.0	9.0	13.0	4.0	9.0
25.0	13.0	5.0	8.0	12.0	4.0	8.0

Superpave5 Concept

- Requires change in N-design

- N-design too high
  - Difficult to design
  - Difficult to get compaction
- N-design too low
  - More likely to rut

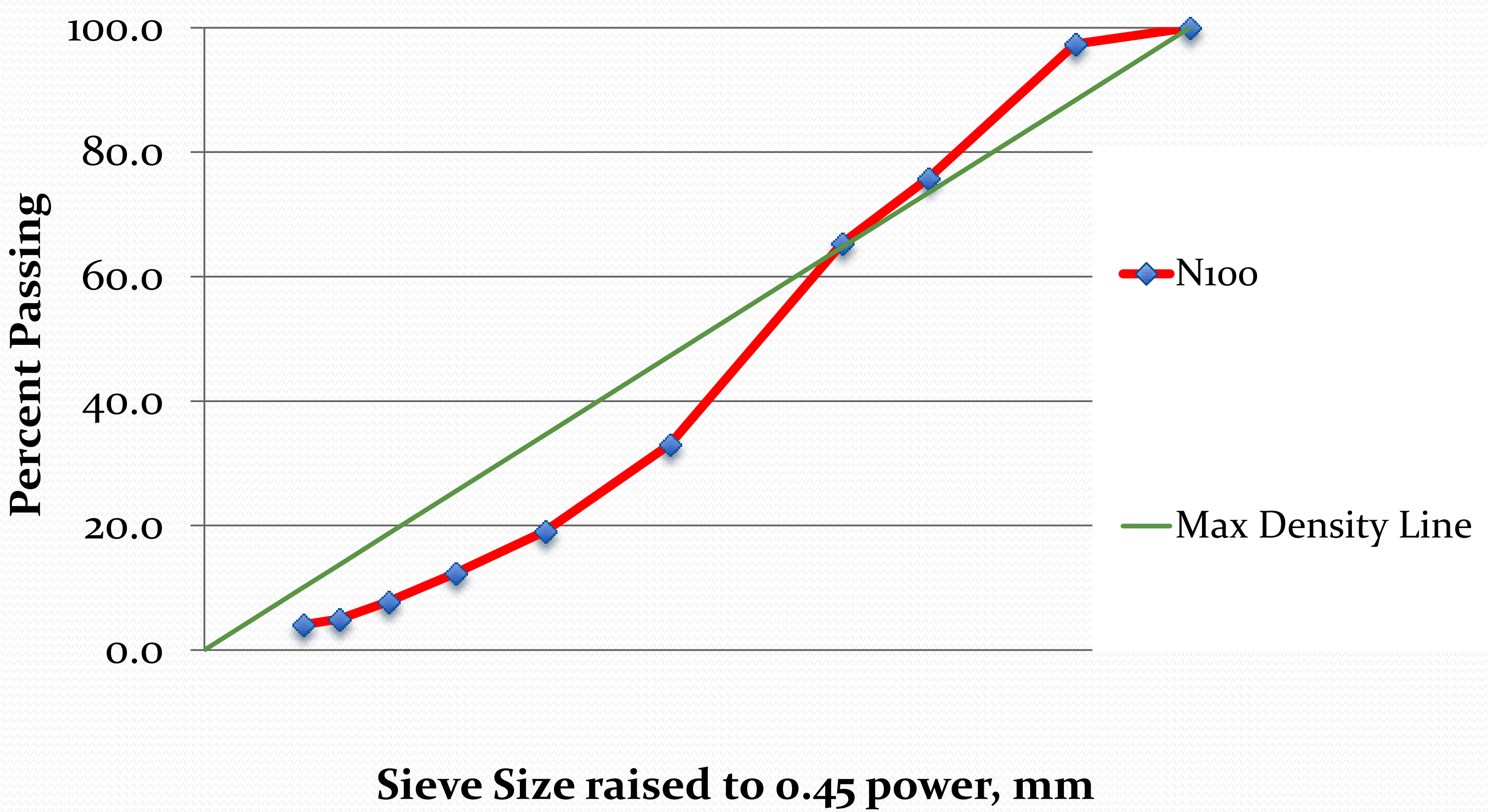
Purdue Study to Set N design

		Mixture Type	
ESAL	Gyrations	9.5-mm	19.0-mm
3-10 million	70	x	
	50	x	
	30	x	
10-30 million	70	x	x
	50	x	x
	30	x	x

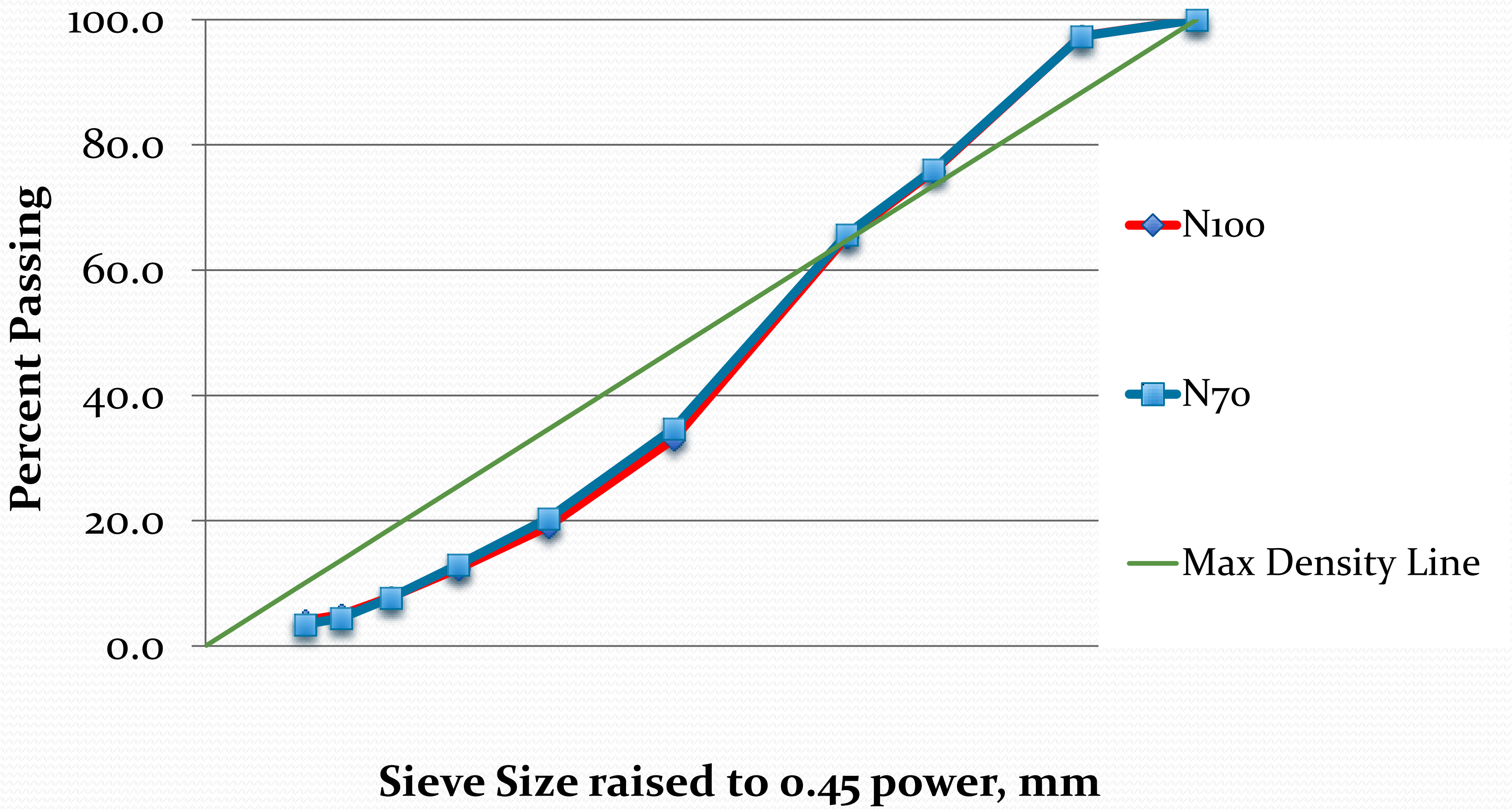
9.5-mm Mixture (Example)

	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

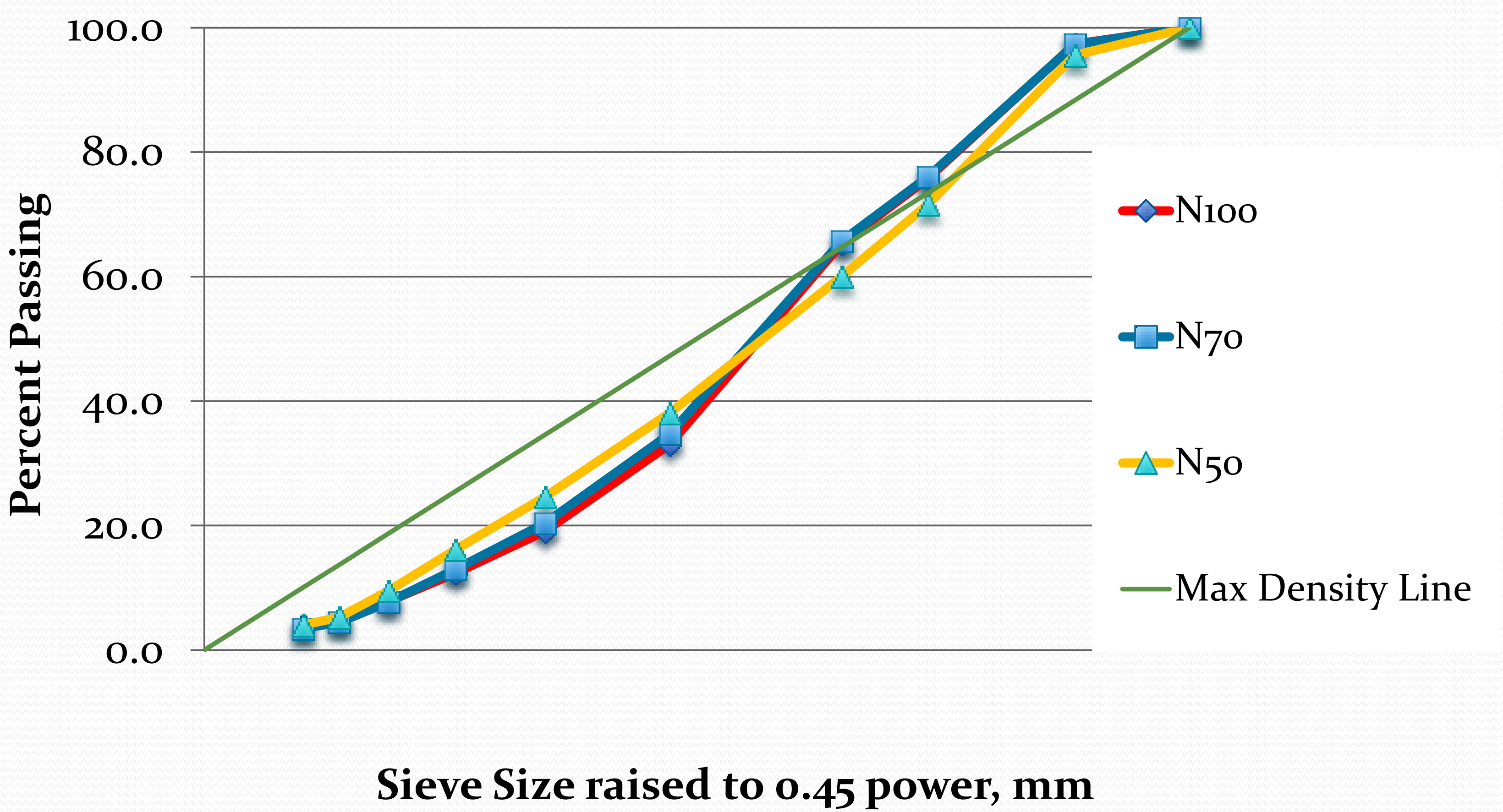
9.5-mm Mixture Gradations



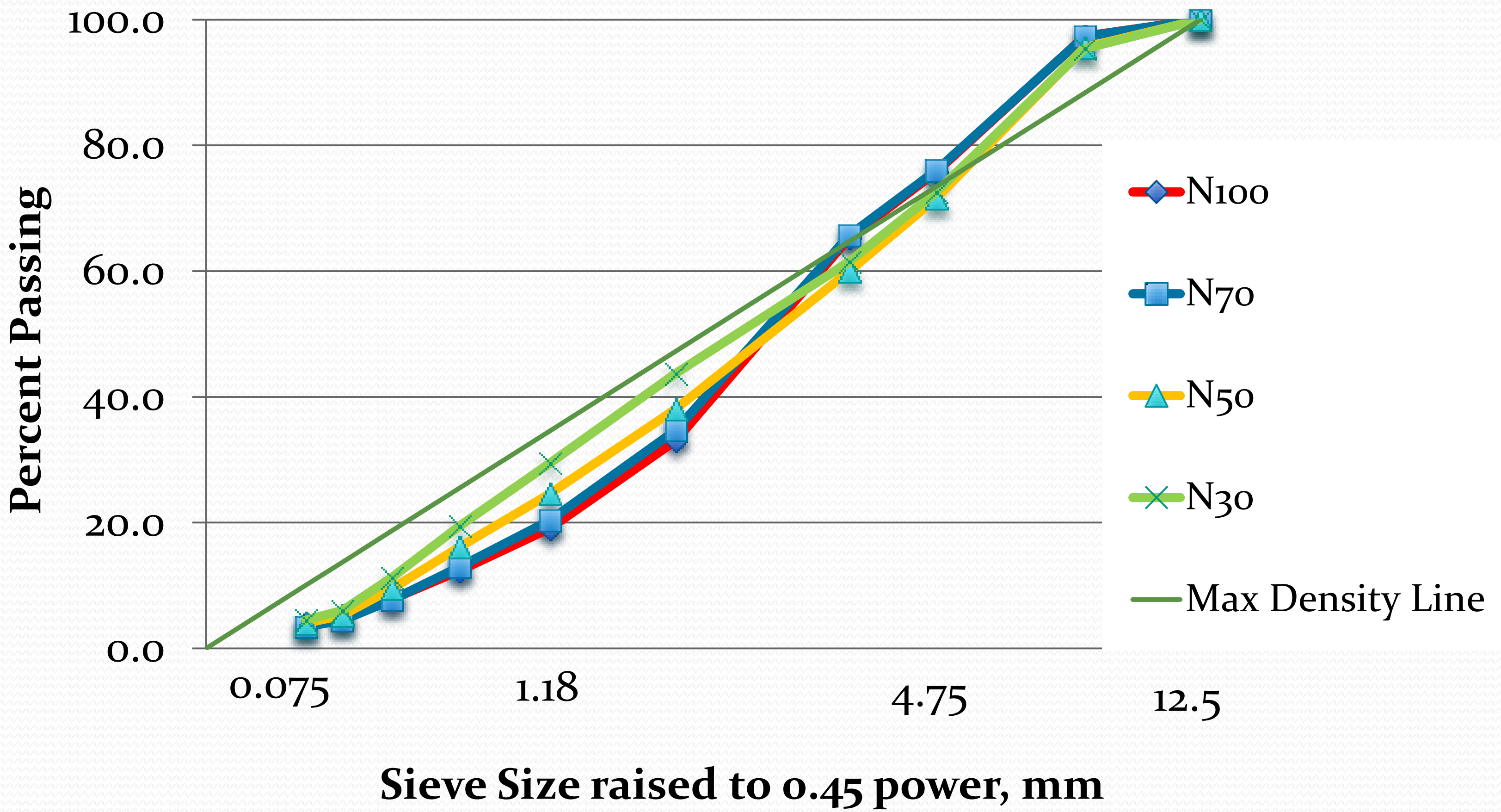
9.5-mm Mixture Gradations



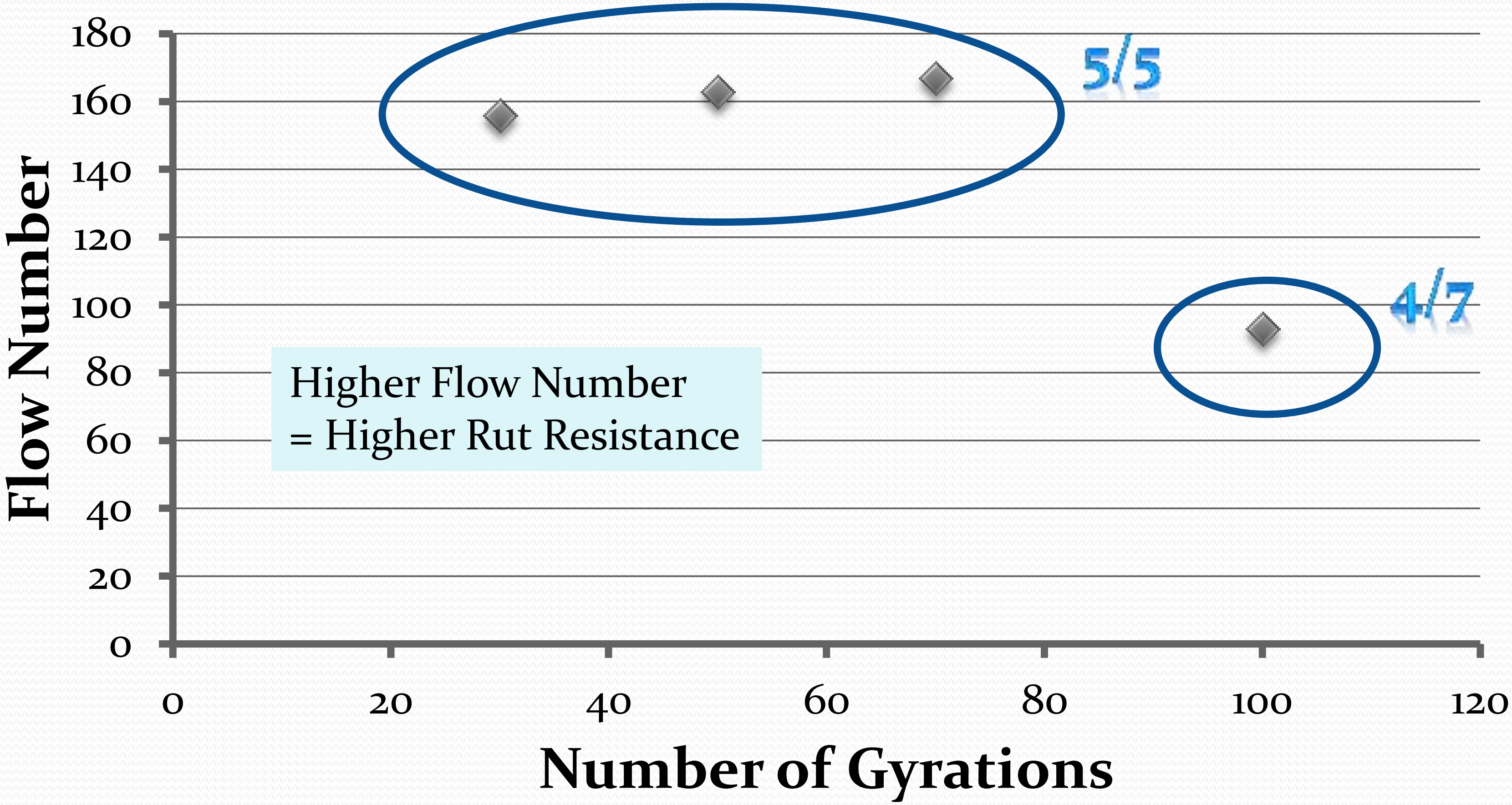
9.5-mm Mixture Gradations



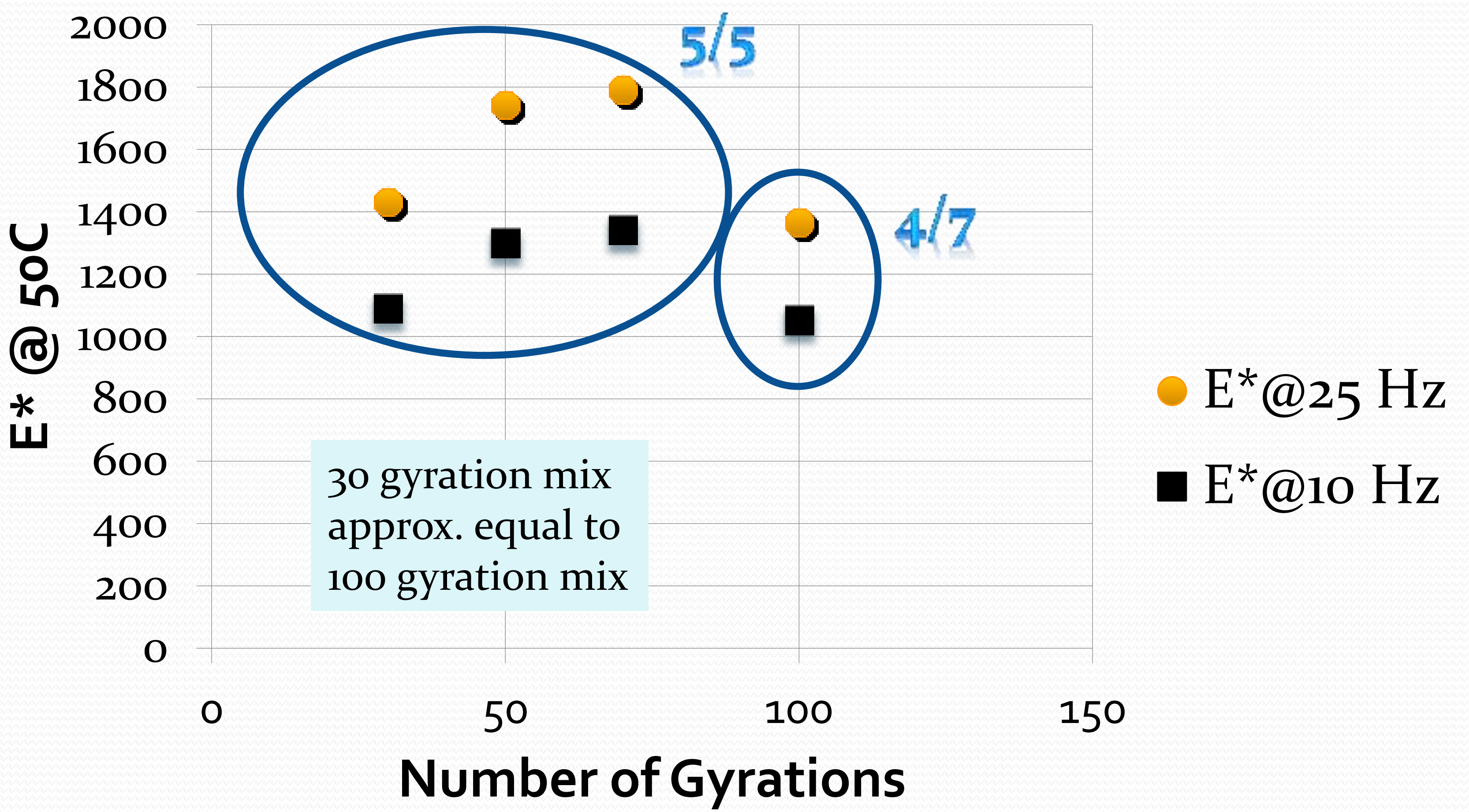
9.5-mm Mixture Gradations



Rut Resistance Comparison



Stiffness 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 NMAS
  - 330 lb/yd^2 (3 inches)

Trial Conditions

- December 12 & 13, 2014
  - Loose samples
  - Cores
- Temperature
  - 34°F to 46°F
  - Light wind

Paving Train

Paving Train

N30 (Superpave5) Mix


N30 (Superpave5) Mix


N30 (Superpave5) Mix


Field Density Quality Control


Research Cores


N30 (5% Air Void) Mix

Plate Sample from Road for QA

Loose Research Samples

Research Samples (N30 and N100)

QA Volumetric Properties

	Superpave5			Superpave4	
	DMF	Sub-lot 1	Sub-lot 2	DMF	Sub-lot 1
% Asphalt	4.8	4.44	4.76	4.6	4.68
Gmm	2.480	2.505	2.494	2.494	2.523
Gmb	2.356	2.362	2.367	2.394	2.411
Air Voids	5.0	5.8	5.2	4.0	4.4
VMA	15.1	14.5	14.7	13.4	12.9

QA Core Density

	Superpave5			Superpave4	
	DMF	Sublot 1	Sublot 2	DMF	Sublot 1
Gmm		2.505	2.494		2.521
Core Gmb 1		2.412	2.345		2.351
Core Gmb 2		2.418	2.398		2.300
%Gmm 1		96.3	94.0		93.2
%Gmm 2		96.5	96.2		91.2
Air Voids 1		3.7	6.0		6.8
Air Voids 2		3.5	3.8		8.8

Superpave5 Field Trial

- Fatigue Testing
  - No aging
  - Long term oven aging
  - Will determine if fatigue properties are improved after aging
- Hamburg
  - New to Indiana

Where Are We?

- Laboratory Study Complete
  - N-design selected at 30 gyrations
- Two trial projects constructed
  - N-design set at 50 gyrations
- Let Trial Project(s)
  - Set up trial specification
  - Let project(s) as Superpave5
- Determine PWL tolerances
  - Air voids
  - VMA
  - Density


Thank You
Flu Shots
The Little Clinic
Greetings from Billy Bob