Building Asphalt Pavements that Perform

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HERITAGE RESEARCH GROUP

Primary Cause of Death (Interstate)

- Rutting
- Fatigue Cracking
- Low Temperature Cracking
- Durability (raveling, block cracking, stripping)
- Other

Indiana Report Card

- Marshall Mix Design
  1980s and early 90s
  - 12 years
    - 6% air void design
    - 30 to 40% natural sand
    - 10 to 12% in-place air voids

- Main Cause of Death
  - Cracking
  - Rutting

Indiana Report Card

- Superpave Mix Design
  - 17 years
    - 4% air voids
    - 10 to 15% natural sand
    - Volumetric acceptance
    - 7 to 8% in-place air voids

- Main Cause of Death
  - Not stripping
  - Not rutting
  - Some cracking
  - Some longitudinal joints

Building Pavements to Perform

- Project 1
  - Existing JCP with HMA Overlay
  - Remove overlay by milling
  - Crack and Seat Concrete
  - Overlay with 5.5 inches HMA

Project 1 Current Condition (2012)

- EB
  - Some delamination in limited area (about 10% length of outside driving lane)
  - Some cracking and deterioration
- Westbound
  - Some cracking and deterioration

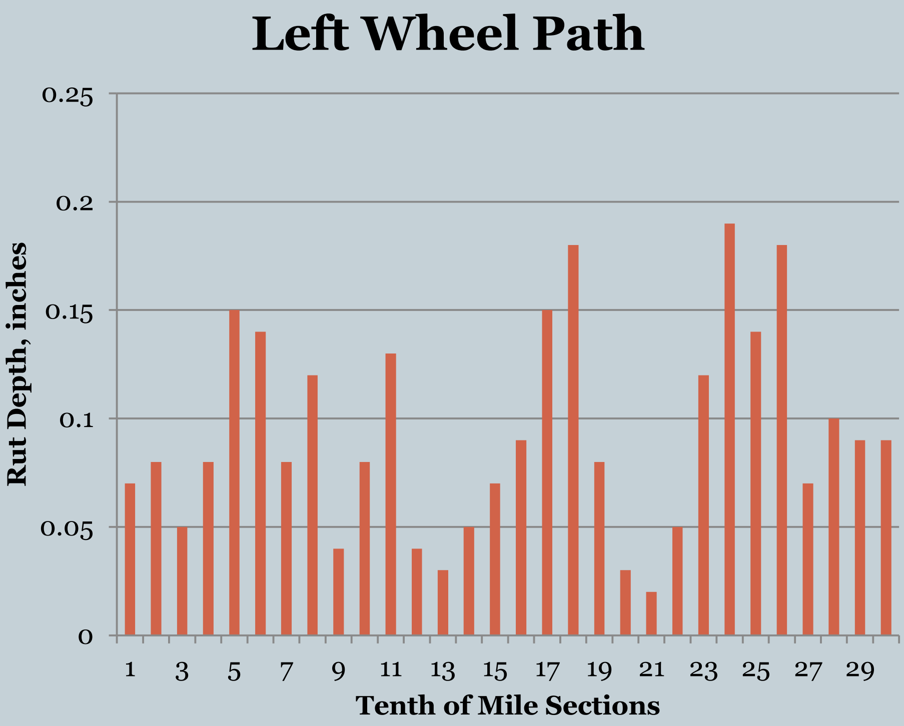
Project 1 EB

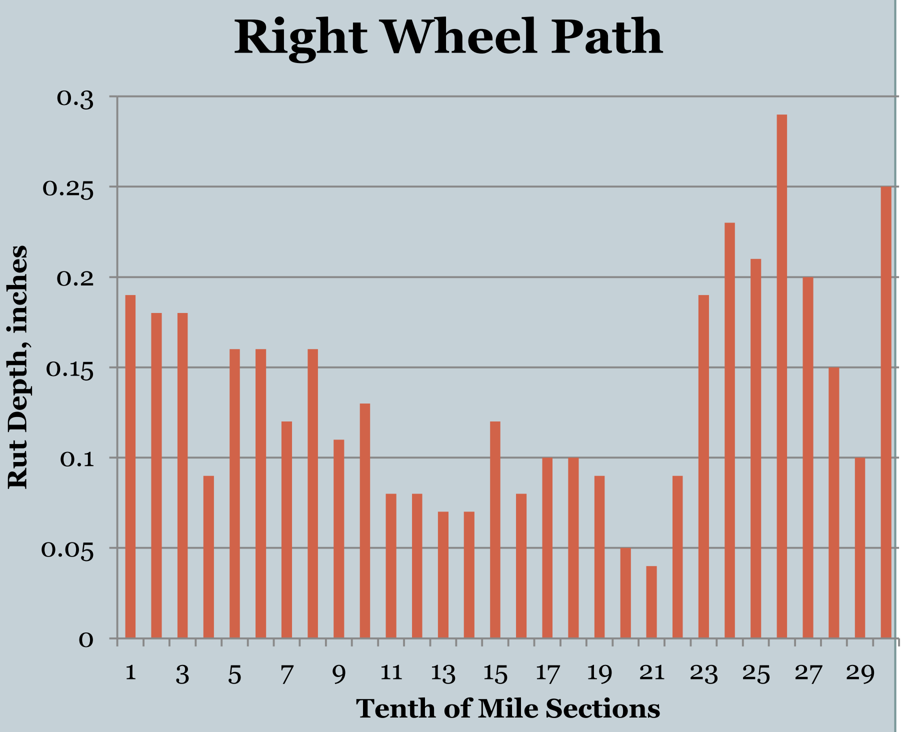
- Typical

Project 1 Westbound

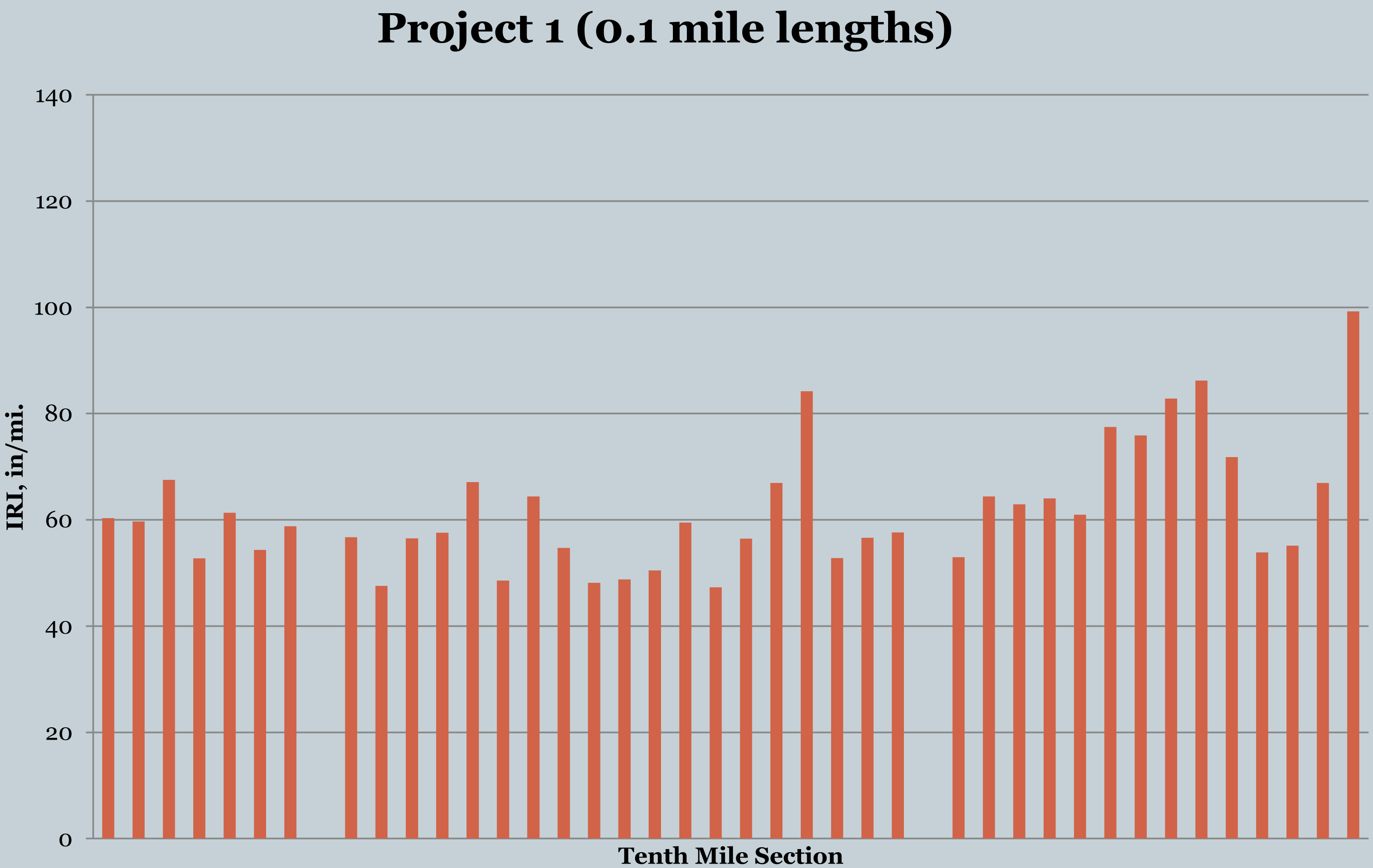
- Typical

Rut Depth Project 1 Westbound



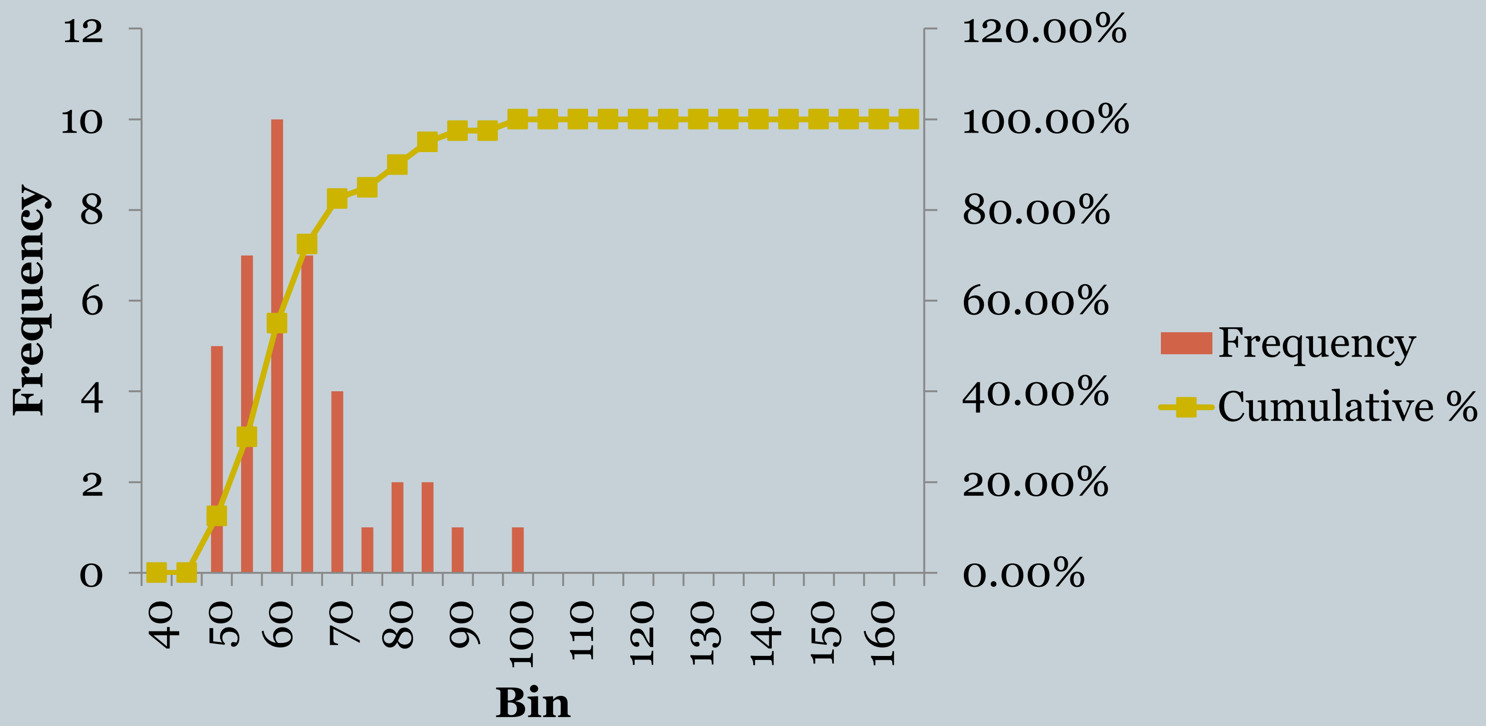


Project 1 Westbound Measured IRI



Project 1 Westbound

- Mean = 62 in/mi
- 90% reliability = 80 in/mi



Building Pavements to Perform

- Project 2
  - Existing JCP with HMA Overlay
  - Mill to remove overlay
  - Rubblize Concrete Pavement
  - Overlay with 12 inches HMA

Project 2 Current Condition (2012)

- All four lanes (age 14 years)
- Almost no distress
- Smoothness about 25 in/mi

Project 2 NB (2012 typical)

- Paved 1998

Project 2 SB (2012 typical)

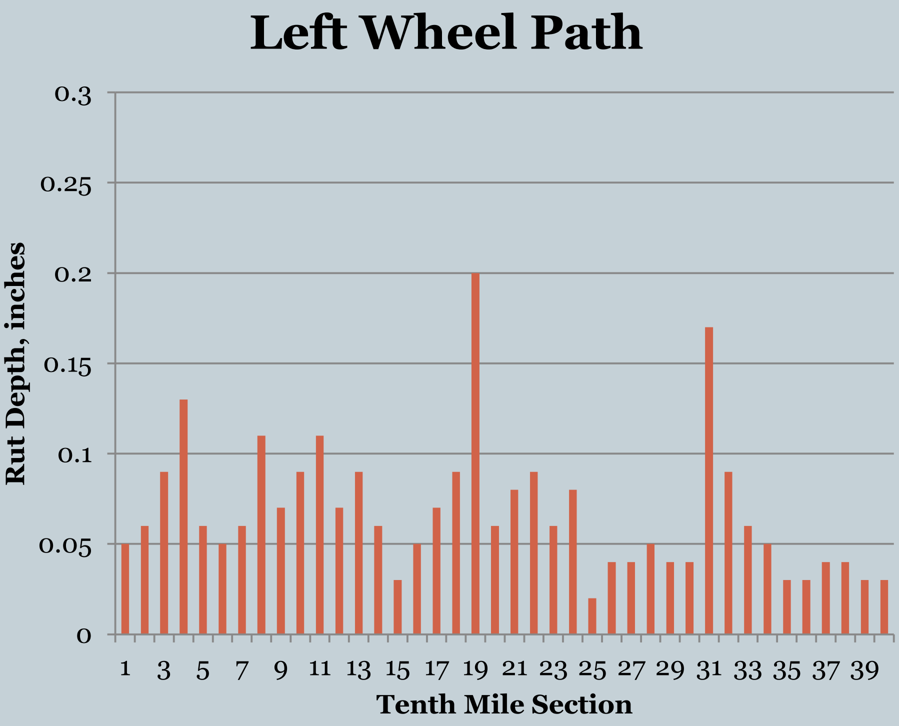
- Paved 1998

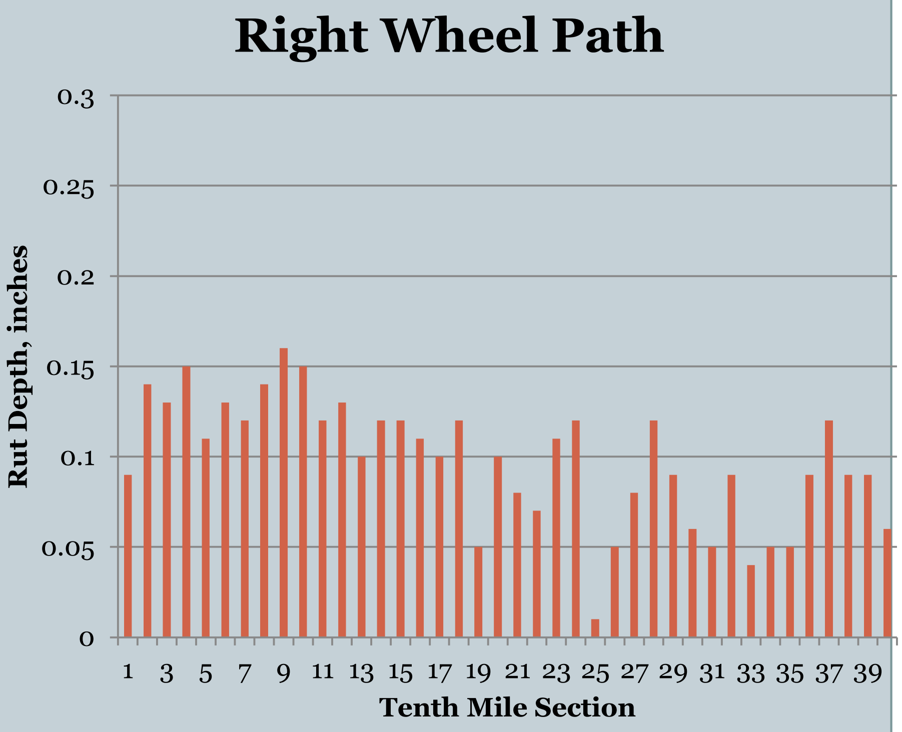
Project 2 Current Condition (2012)

- Southbound
  - Some cracking and deterioration

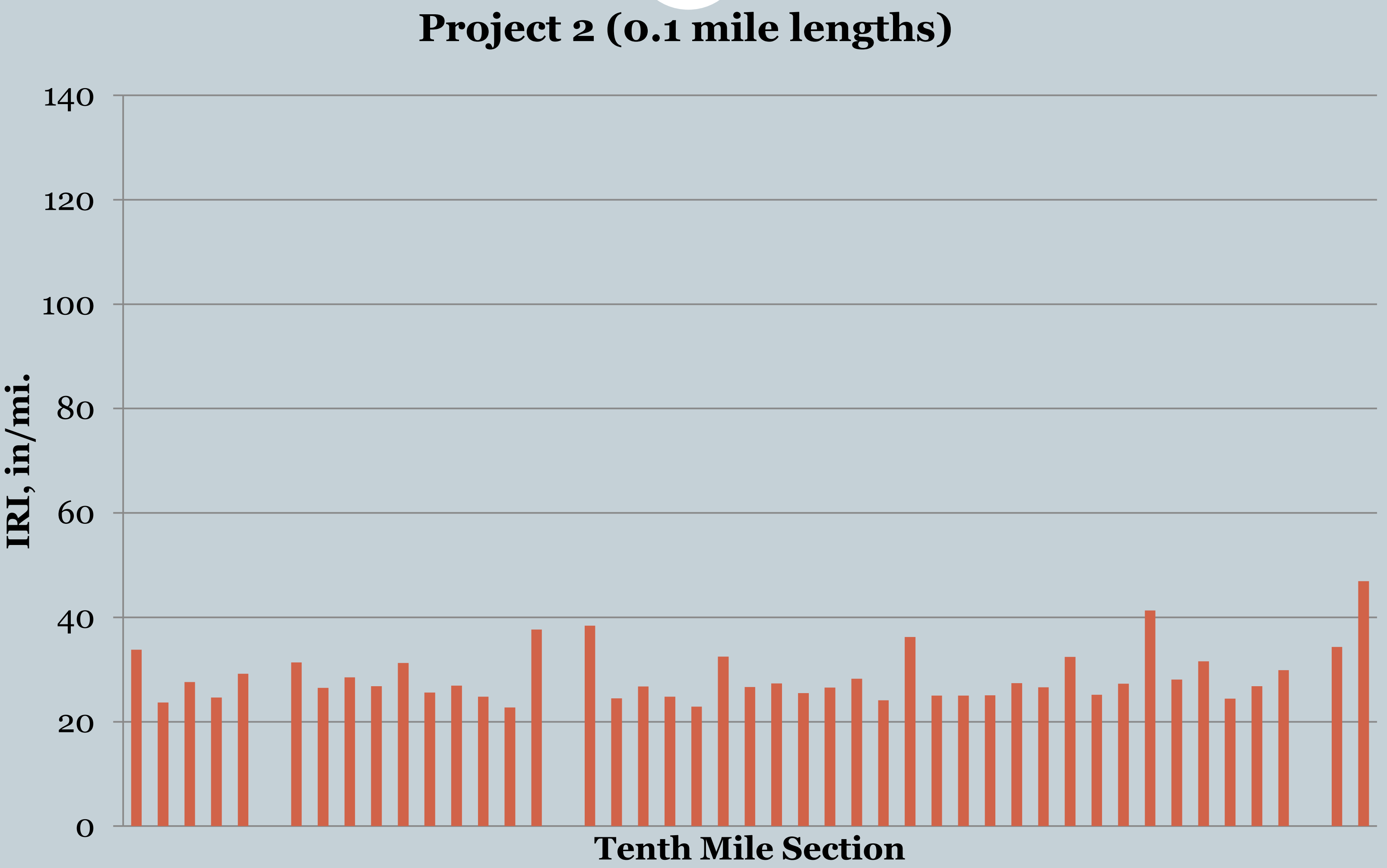
- Northbound
  - Some cracking and deterioration

Rut Depth Project 2 Southbound



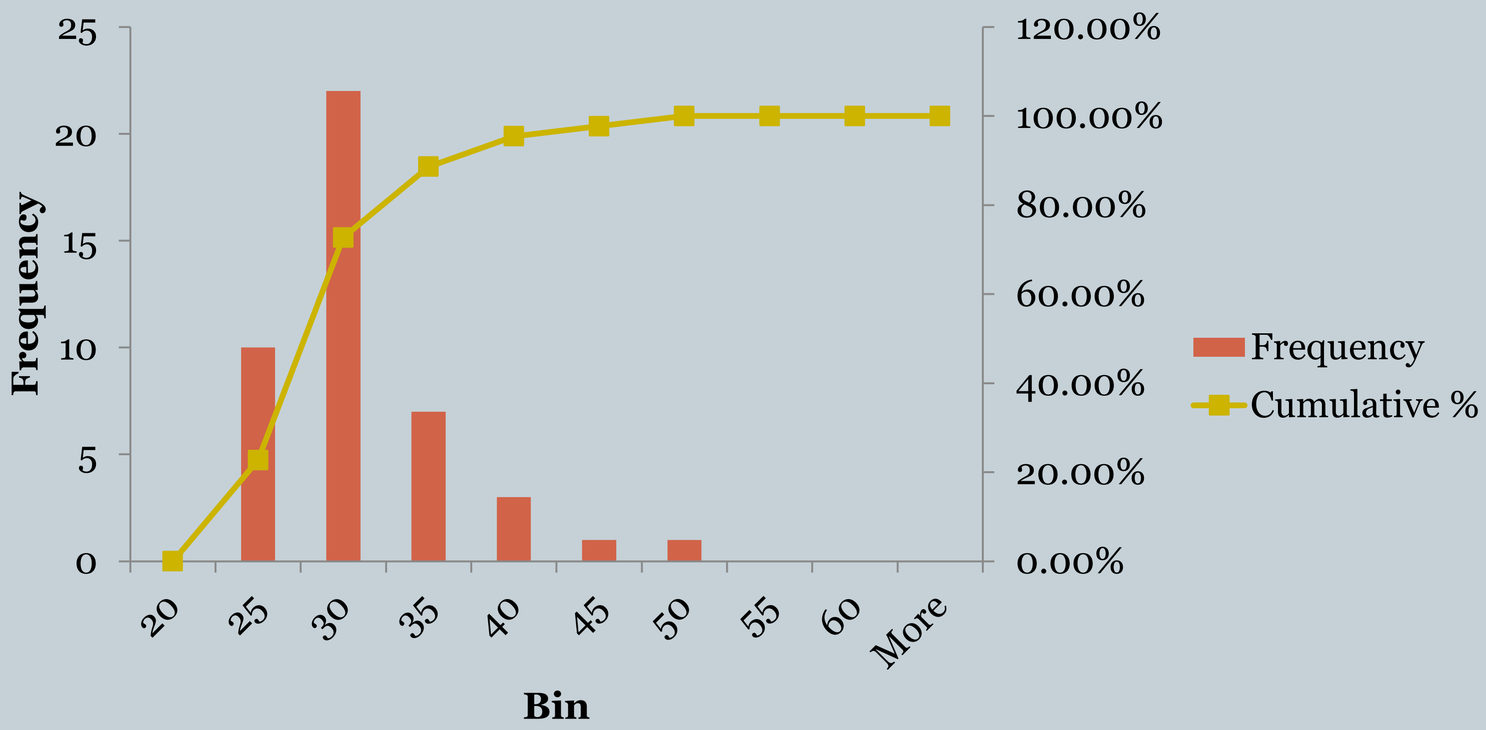


Project 2 Southbound Measured IRI



Project 2 Southbound

- Mean = 29 in/mi
- 90% reliability = 36 in/mi



Pavement Condition at Age 14 years

Project	Project 1 EB	Project 1 WB	Project 2 SB	Project 2 NB
IRI Mean	71	62	29	30
90^{th} Percentile	100	80	36	38
Rut Mean	0.10	0.11	0.08	0.08
90^{th} Percentile	0.16	0.19	0.13	0.17

Keys to Good Performance

- Design
  - Adequate asphalt binder
- Production (PWL)
  - Air voids acceptance
  - VMA (asphalt binder content) acceptance
- Placement (PWL)
  - Segregation
  - Density
  - Joints

Optimizing Laboratory Mixture Design as it Relates to Field Compaction

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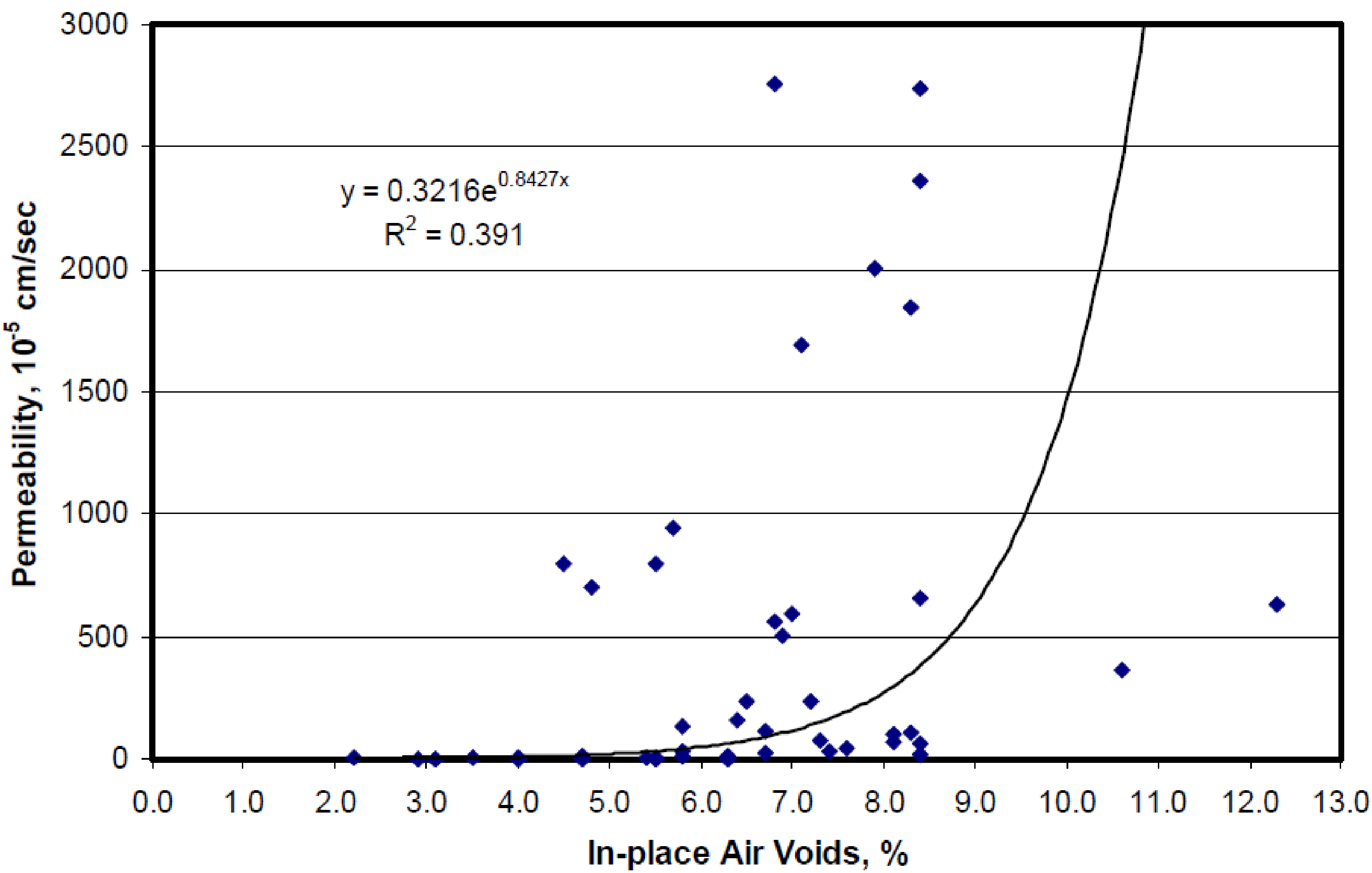
NCAUPG Meeting

23 January 2013

St. Louis, MO

NCAT Study (Report 03-02, Mallick et al.)



Concept

- Low field air voids improves durability
- Requires changing mixture design process
- Keep effective binder content (volume) the same
- Design at 5% and compact to 5%
  - Keep the voids at 5% (reduce traffic densification)

Perform Three Mix Designs

- Two 9.5 mixtures
  - 3-10 million ESALs
  - 10-30 million ESALs
- One 19.0-mm mixture
  - 10-30 million ESALs
- 100 gyration mixtures
  - Dolomite
  - Limestone
  - Blast furnace slag
  - PG 64-22

Approach

- Adjust gradation to achieve 5% voids at different gyrations
  - 70, 50 and 30 gyrations
  - Maintain effective binder content in 5% air void mixtures
  - Bailey method used to guide adjustments

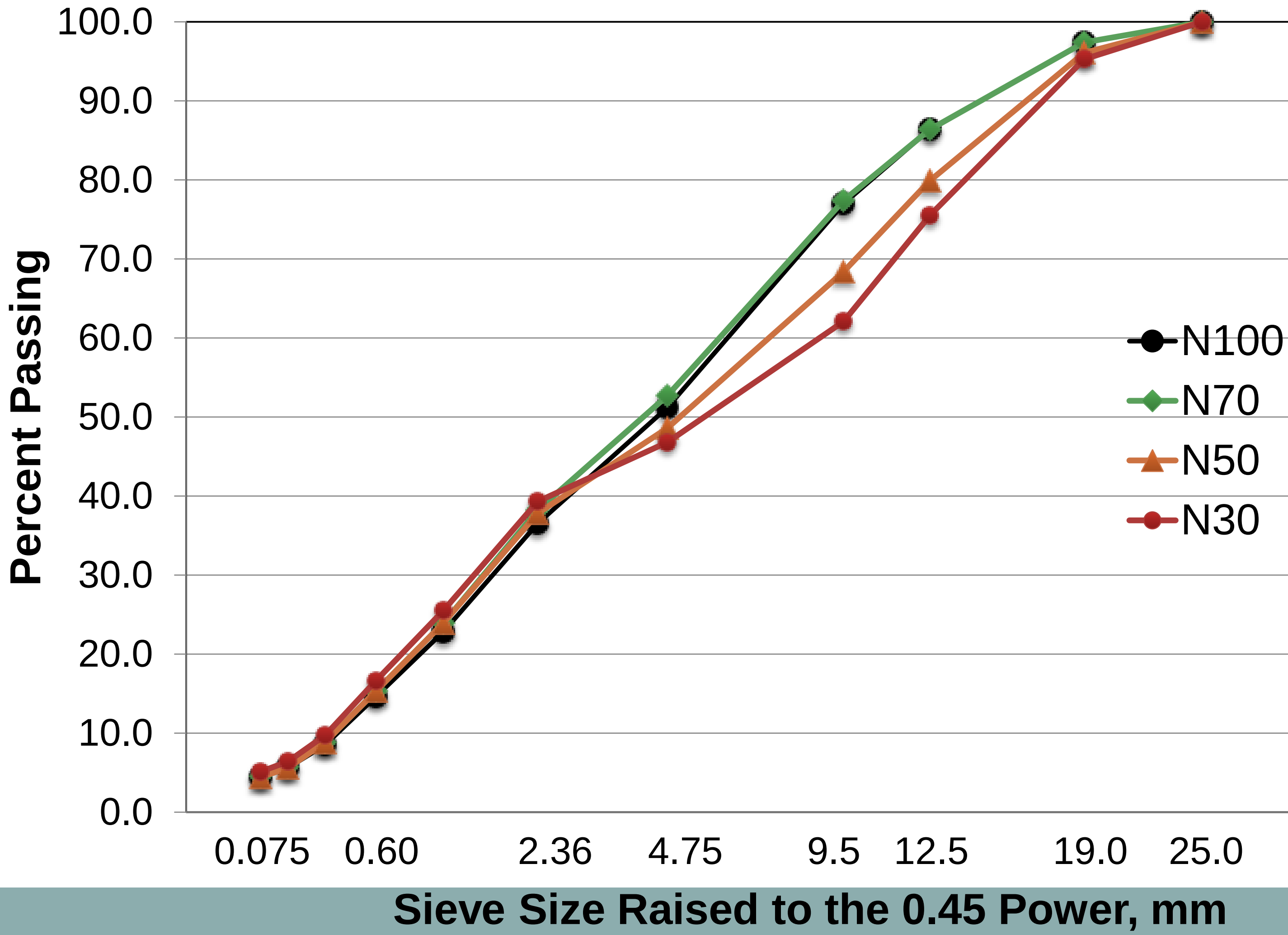
Experimental Matrix

		Mixture Type	
Traffic (ESAL)	No. of Gyrations	9.5-mm	19.0-mm
3-10 million	30	x	
	50	x	
	70	x	
10-30 million	30	x	x
	50	x	x
	70	x	x

19.0-mm Mixture Designs

	Trial Number			
	N100	N70	N50	N30
P_b, %	4.7	4.7	5.1	5.1
P_{be}, %	4.1	4.1	4.1	4.1
V_a, %	4.0	4.9	4.9	4.9
VMA, %	13.6	14.5	14.4	14.9
VFA, %	70.7	66.2	65.9	67.2

Mixture Gradations



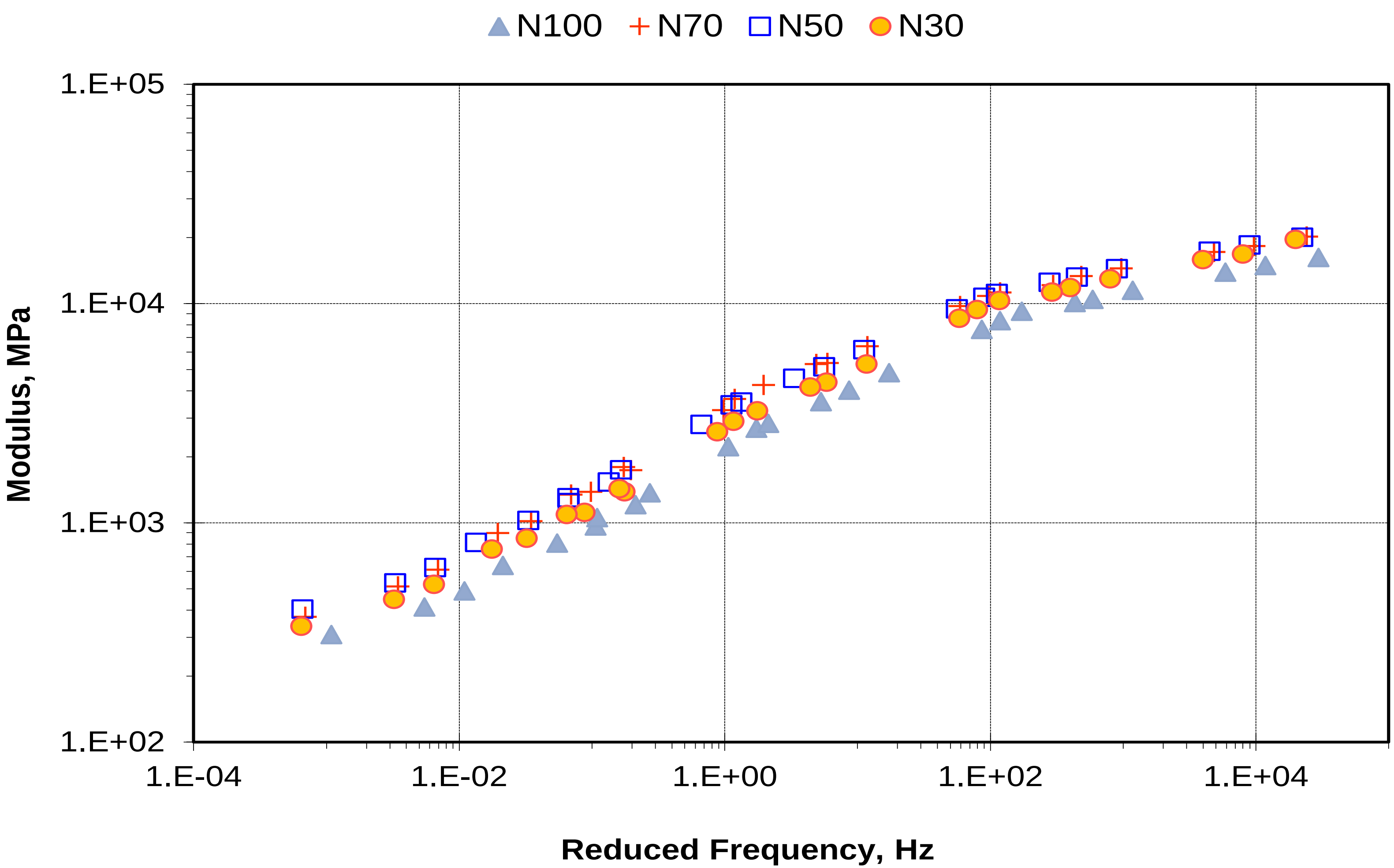
Approach

- Test mechanical properties of mixtures
  - Same (or better) mechanical properties in the 5% air void mixtures
  - Do not sacrifice rutting resistance for higher density
  - Test 100 gyration mixtures at 7% and others at 5% air voids
  - Determine number of gyrations to achieve 5% air voids and similar (or better) mechanical properties

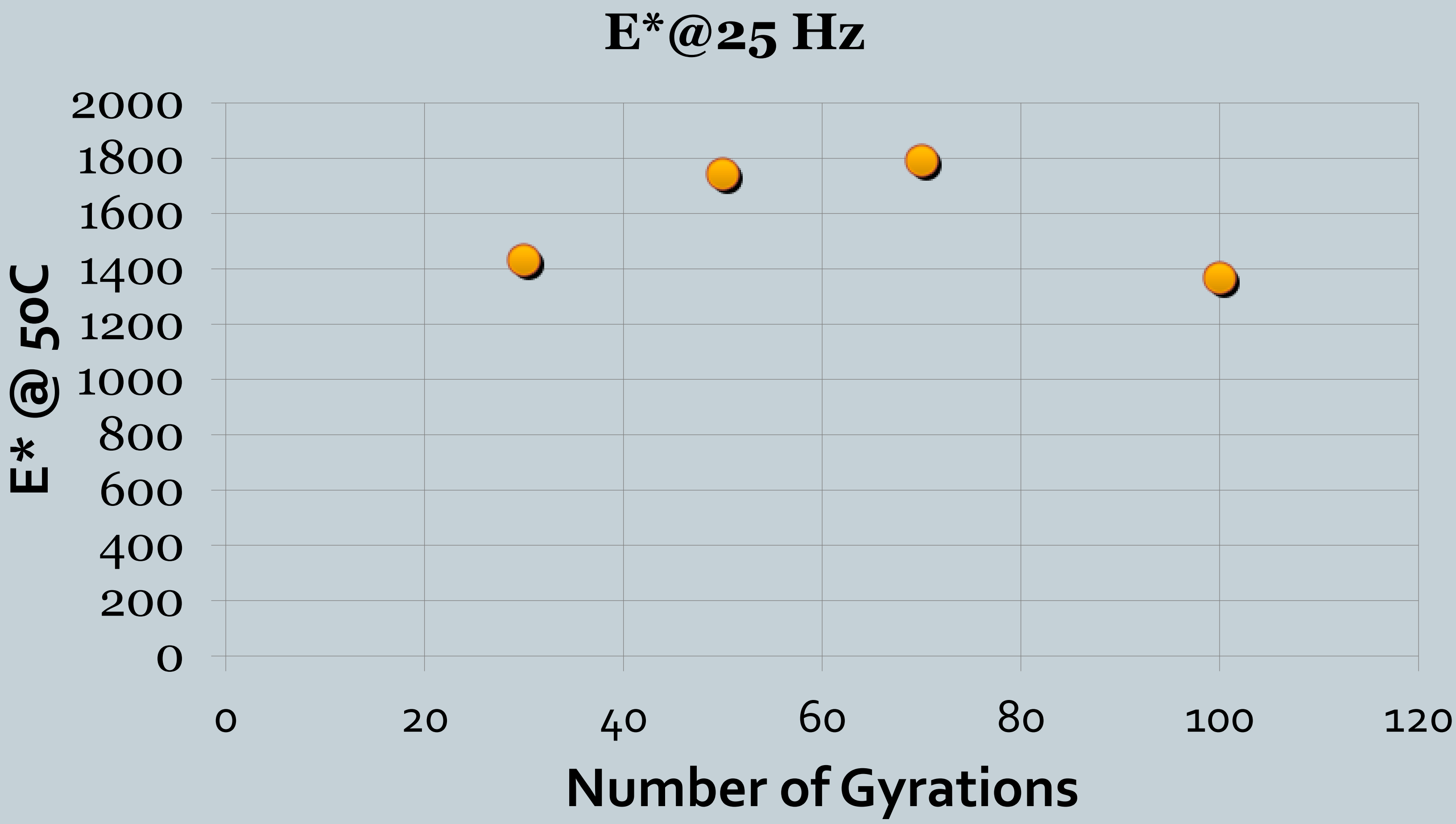
Testing

- Dynamic modulus test
  - Stiffness
  - Rutting
  - Fatigue cracking
- Flow number test
  - Rutting

Dynamic Modulus Results



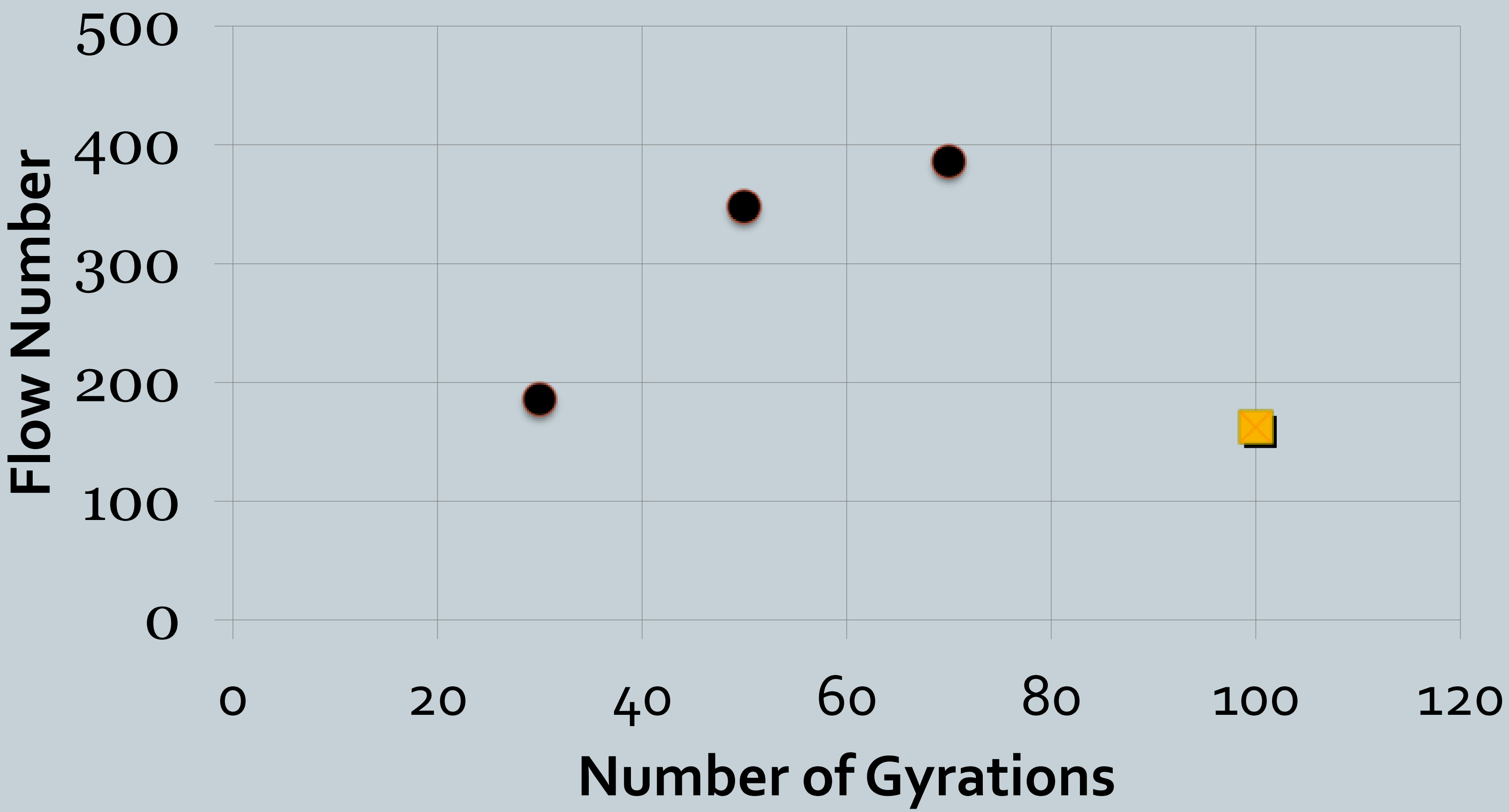
Dynamic Modulus @ 50C



Flow Number Results

Gyrations	Average Flow Number
100	162
70	386
50	348
30	185

Flow Number



500
400
300
200
100
0
Flow Number
0
20
40
60
80
100
120
Number of Gyrations

Summary

- Design HMA at 5% air voids
- Construct to 5% air voids
- Rut resistance improved
- Stiffness improved
- Durability improved
- Pavement life improved