Friction Courses in the Southeast

2006 Southeast Pavement Management and Design Conference

May 9, 2006

Overview of New-Generation Open-Graded Friction Courses

- Background
- Benefits
- Materials
- Mix design
- Construction
- Noise Reduction

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History of OGFC

- First Use in 1944
- FHWA Design Procedure in 1974
- Stripping of Underlying Layer
- Quick Failure Mode (Raveling)
- Moratorium in 1980s
- Needed Improvements

Use of OGFC

- 38% Still Use
- 38% Discontinued Use
- 8% Do Not Use
- 16% Did Not Respond

Based on 1998 Survey

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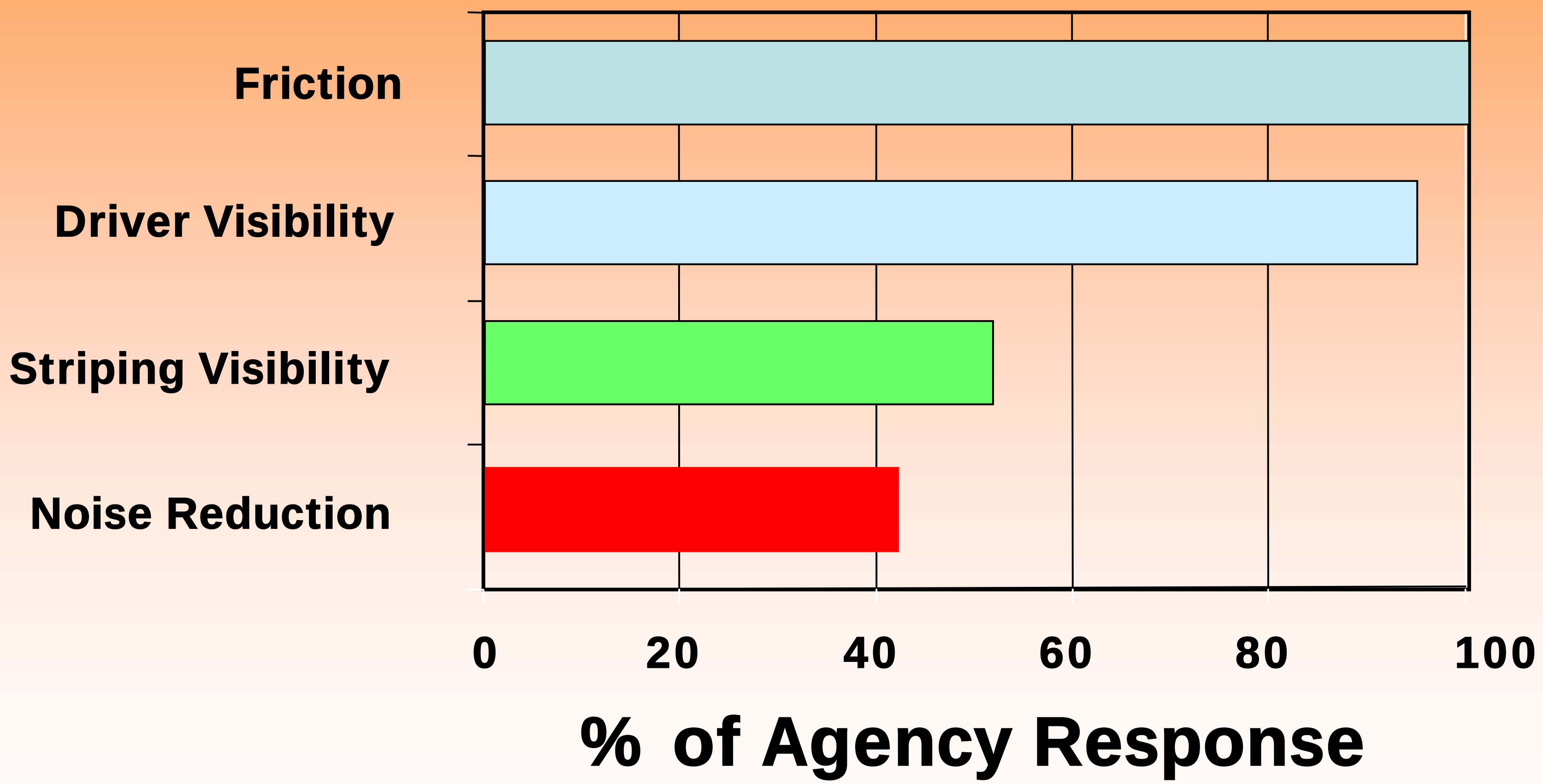
Benefits of OGFC



NCHRP Synthesis 284

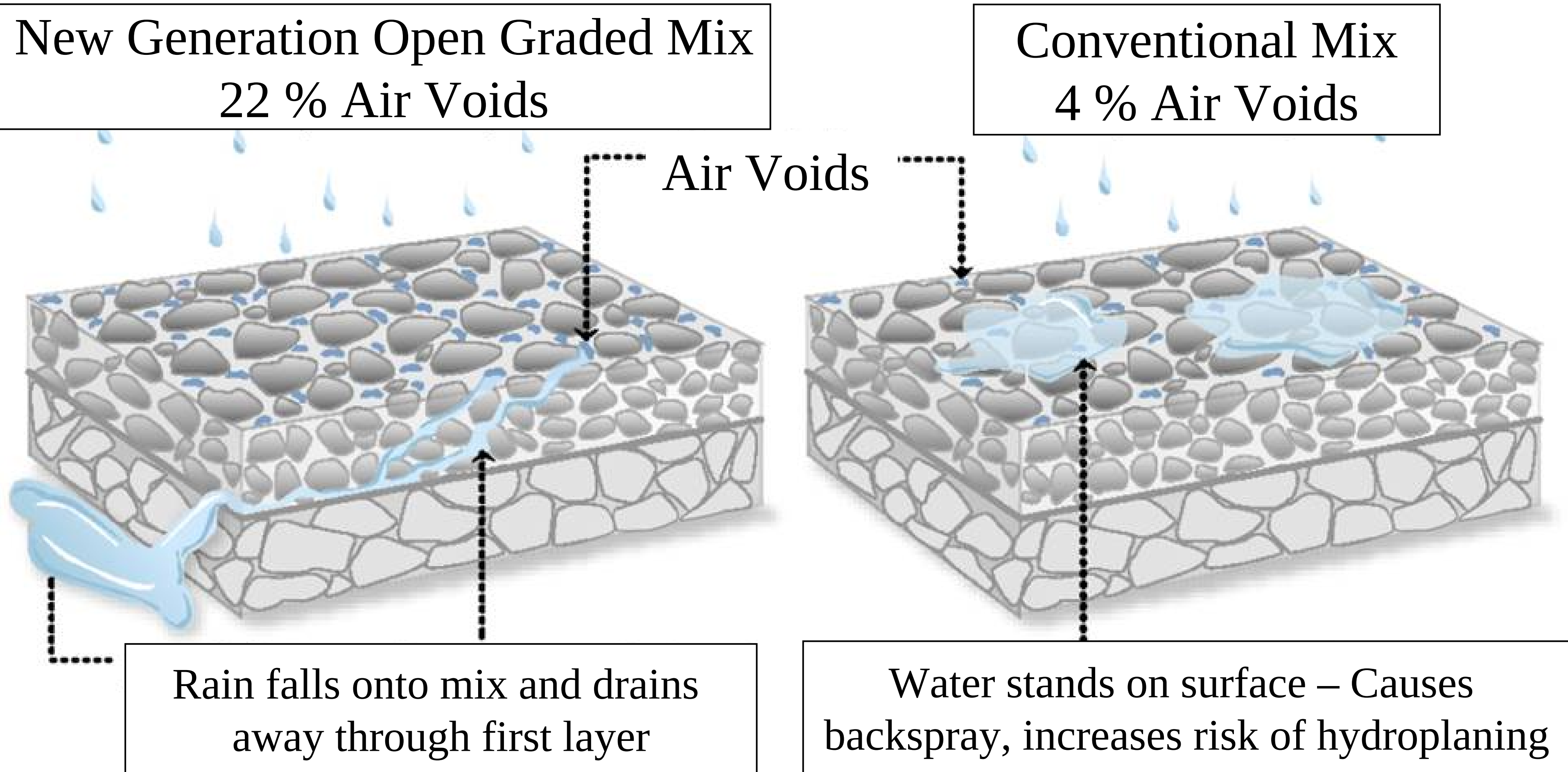
Friction

Driver Visibility

Regular Surface

OGFC Surface

Benefit – Reduces Hydroplaning



Advantages

- Provides Water Drainage
  - Reduce Hydroplaning
  - Improve Friction
- Improves Visibility
  - Reduce Splash/Spray
  - Improve Visibility of Traffic Stripes
  - Reduce Headlight Glare
- Improves Smoothness
- Reduces Noise

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Selection of Materials

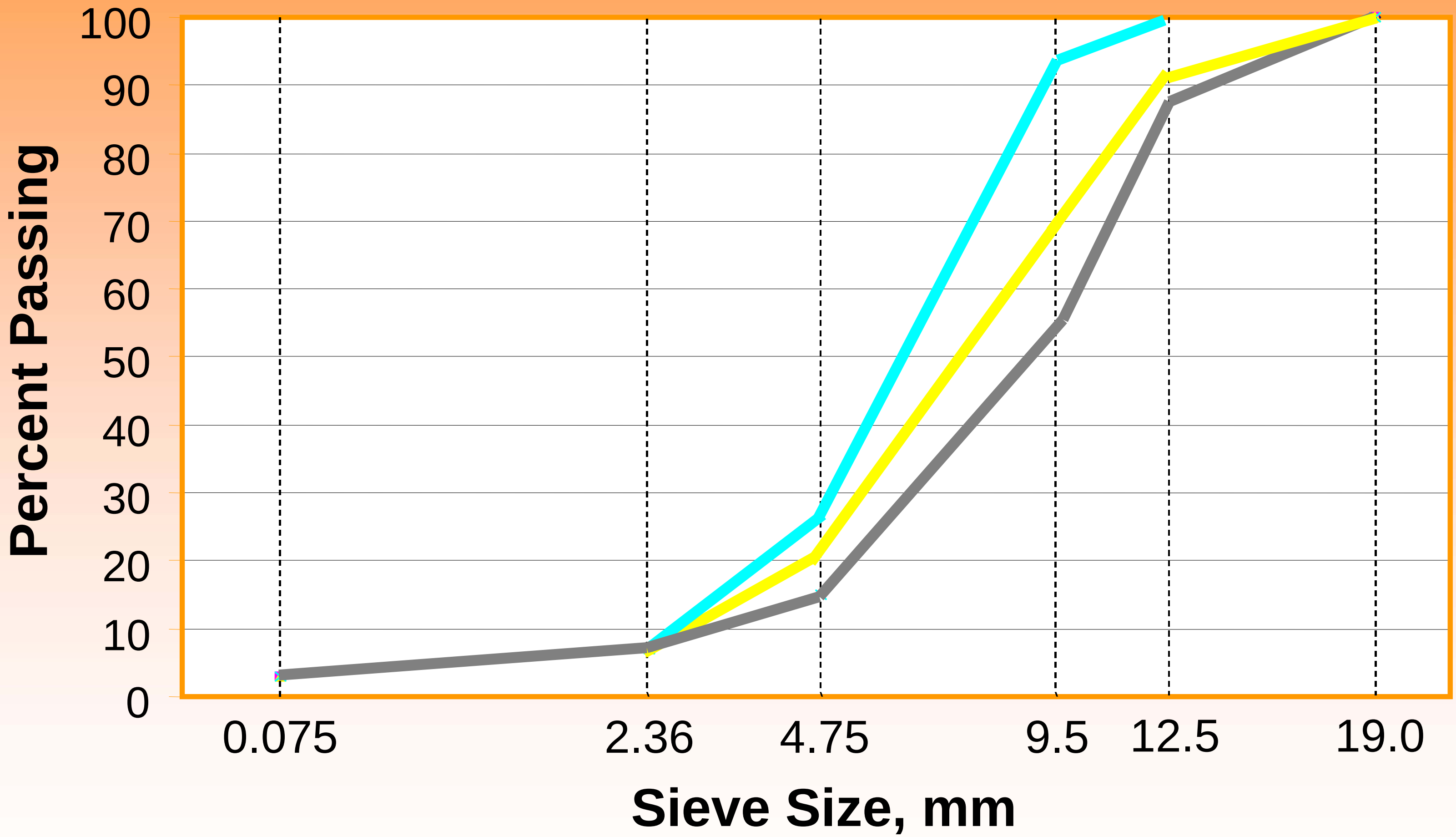
Aggregate for OGFC

- High quality coarse aggregate
  - Hard
  - Angular (Nearly cubical)
  - Rough textured

Gradation Range

Sieve, mm	Percent Passing
19.0	100
12.5	80 – 100
9.5	35 – 75
4.75	10 – 25
2.36	5 – 10
0.075	0 – 4

Typical Gradations



Asphalt Binder for OGFC

- Most U.S. projects use a polymer modified asphalt PG 76-22

(Bump high temperature by two grades)

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Primary Function of Stabilizer

- Prevent Draindown
- Stabilizers hold AC in place during mixing, hauling and placement
- Most stabilizers do not add significant “strength”

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Types of Stabilizers

- Cellulose Fiber
  - Loose
  - Pellets
- Mineral Fiber
- Polymer
- Crumb Rubber

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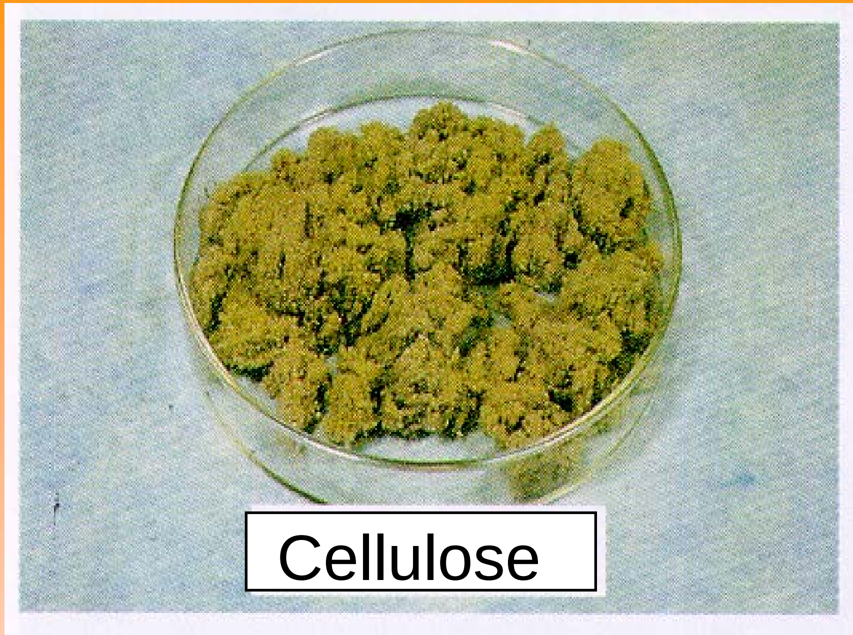
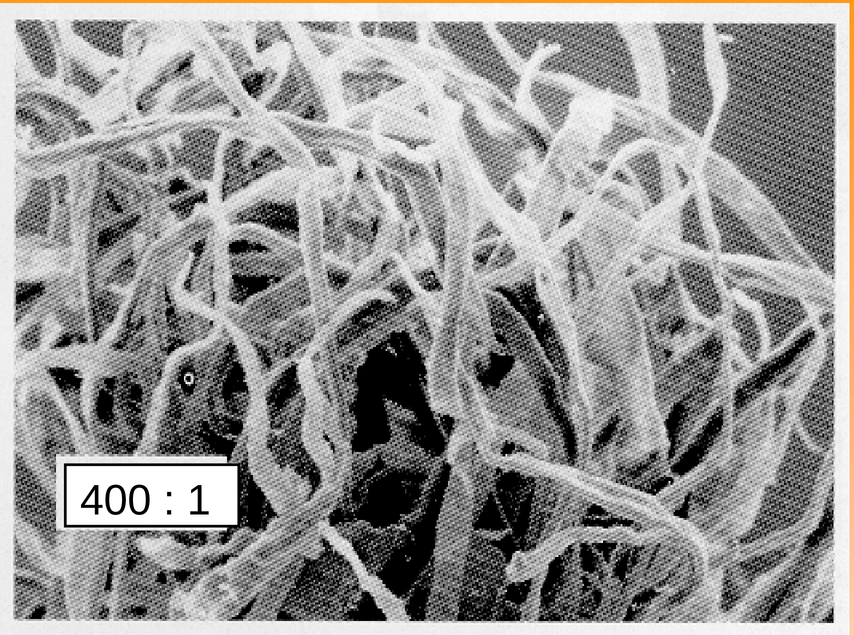
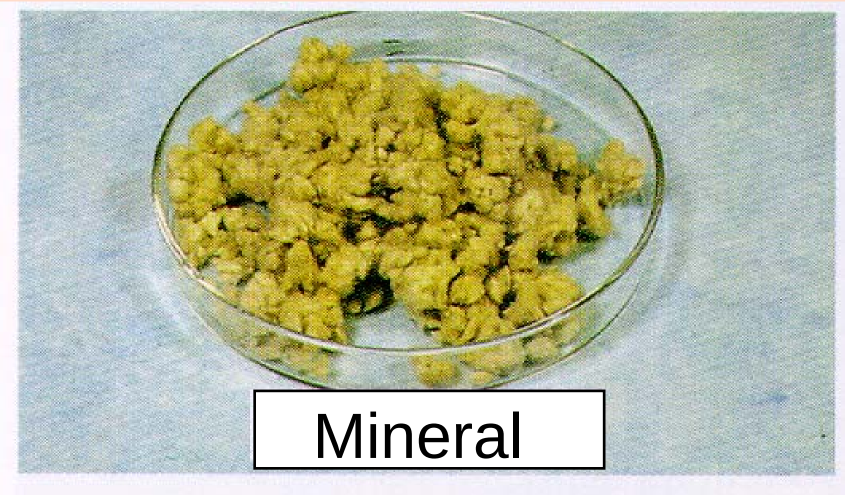
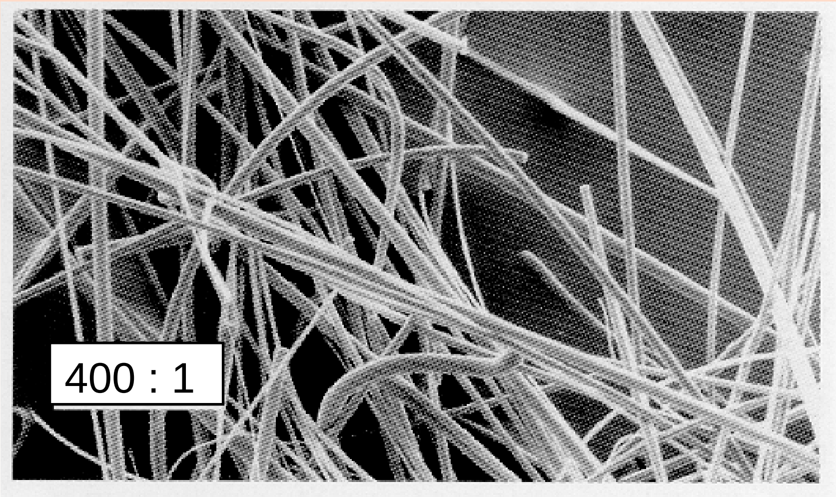




Fibers for Draindown





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Mix Design Method

- FHWA Procedure – 1974 ?
  - Surface Capacity Test
  - Pyrex Bowl Method
- Modified Marshall Design ?
- Superpave Gyratory ?

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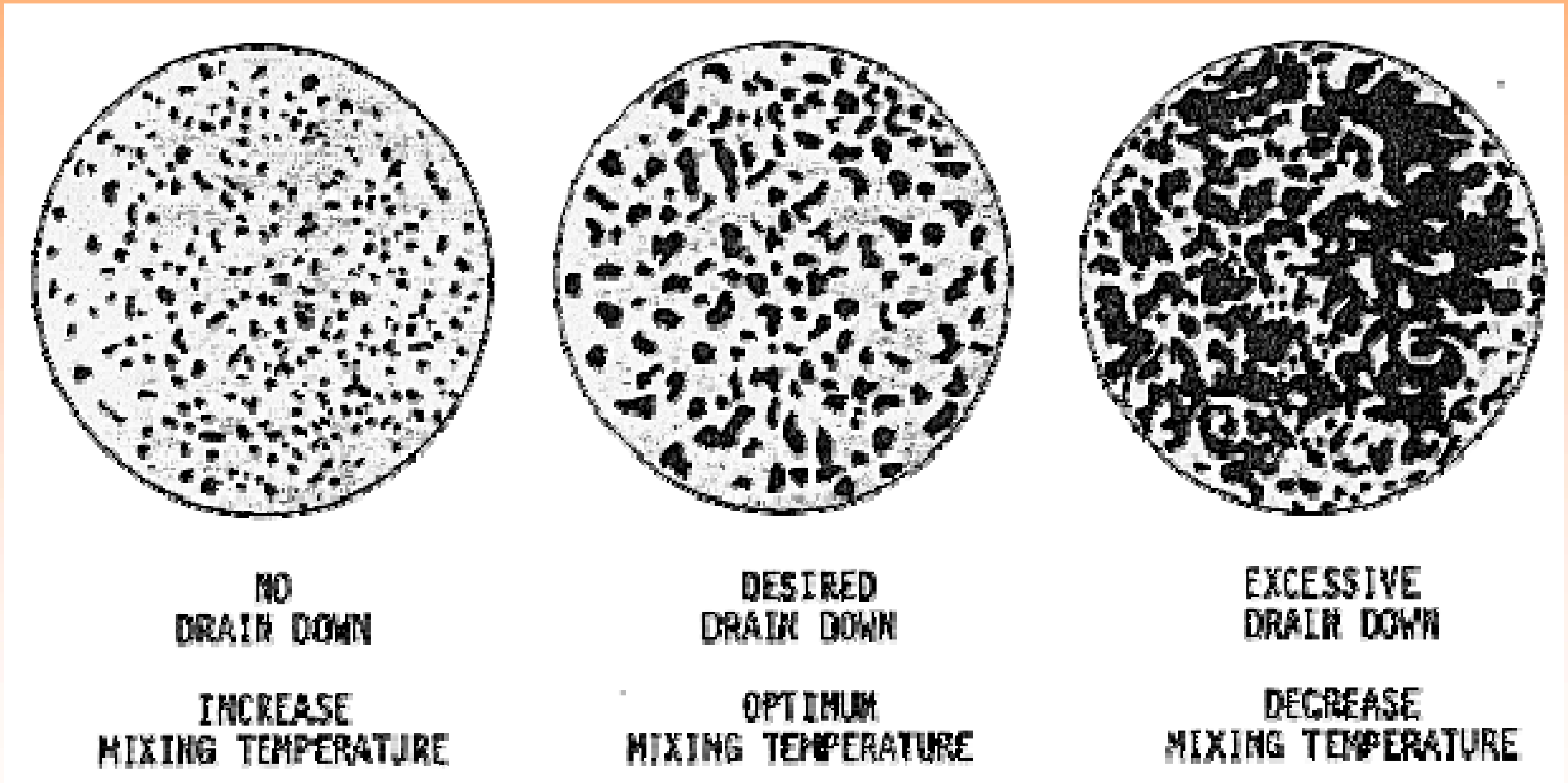
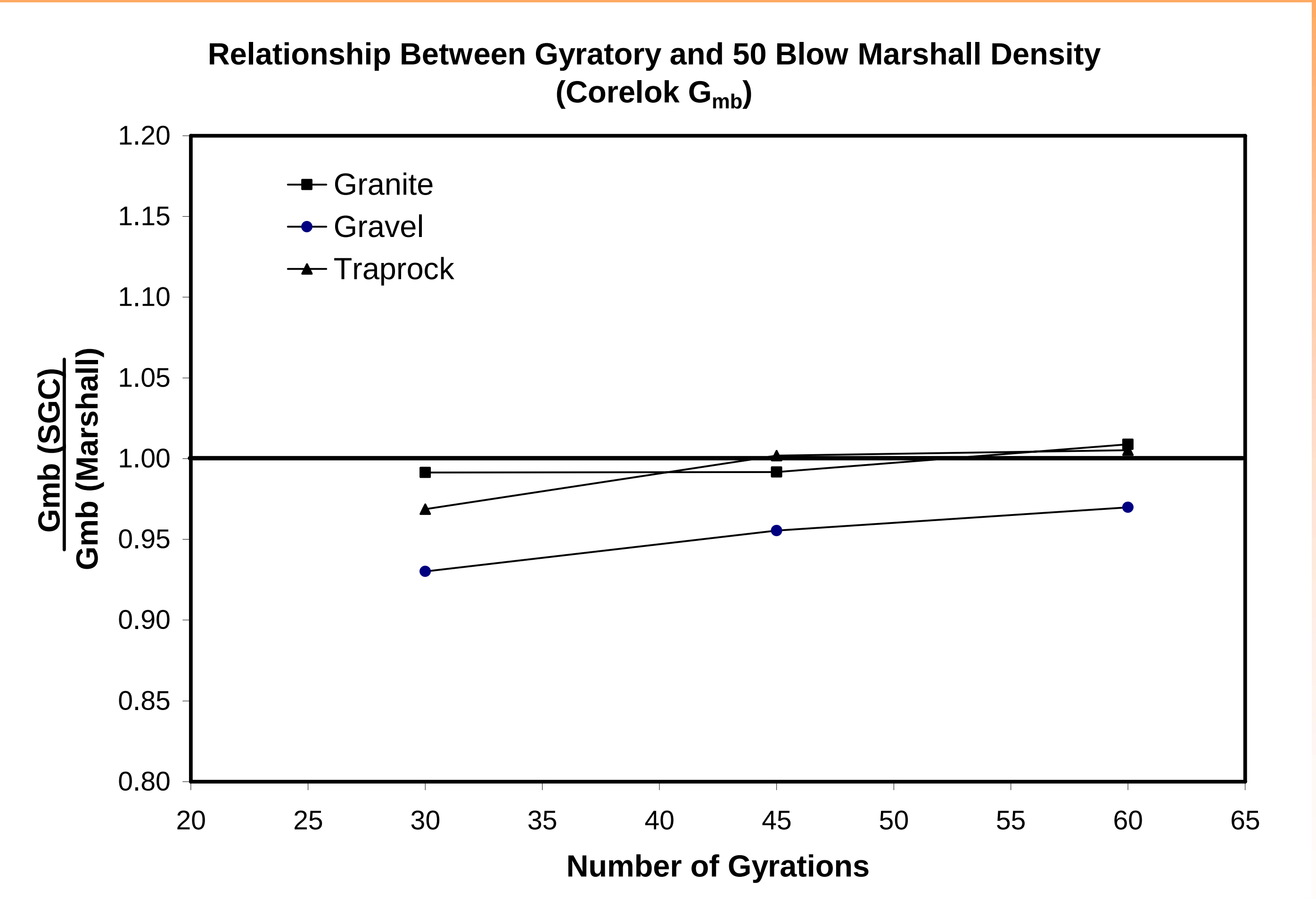
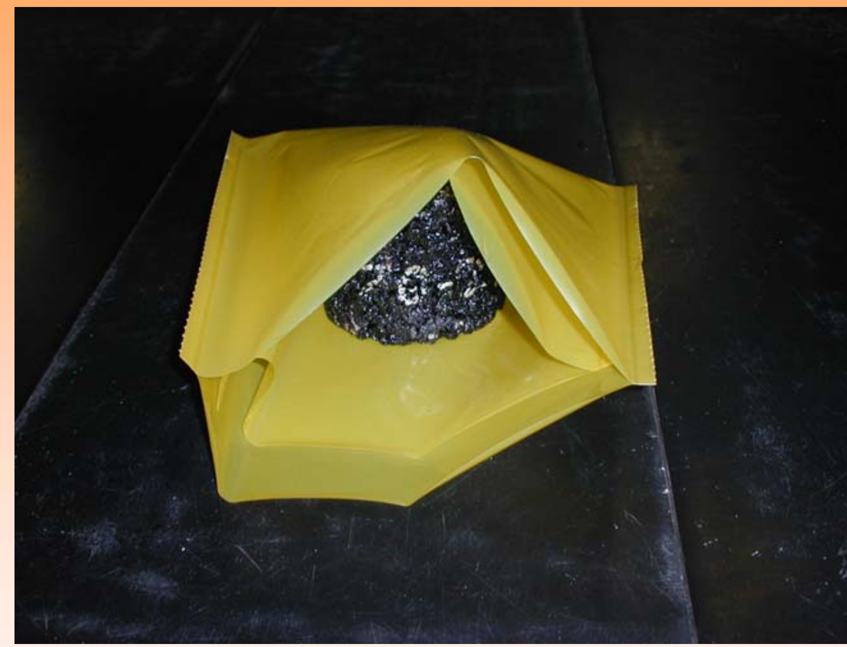
Mixing Temperature
Optimum AC Content



N_{design} - Compaction



CoreLok Density



Double Bags were Necessary

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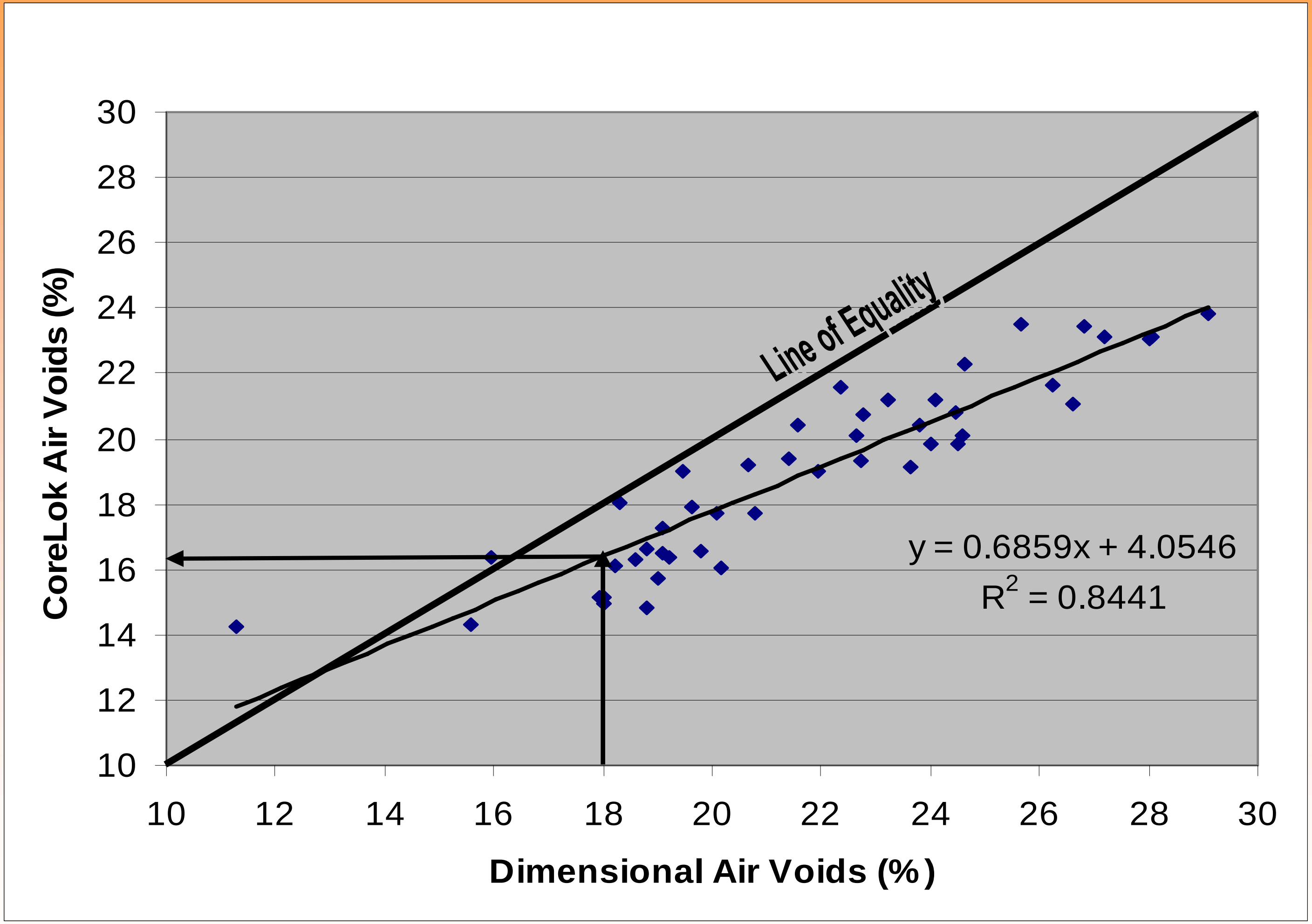
Dimensional vs CoreLok



Conclusions from Compaction Study

- N_{design} for OGFC - Use 50 gyrations
- More aggregate breakdown with Marshall hammer
- CoreLok is more accurate for determining air voids than dimensional method
- Minimum air voids should be:
  - 16% for CoreLok
  - 18% for Dimensional

Test Methods

- Stone-on-Stone
- Draindown
- Permeability
- Abrasion
  - Cantabro Test
- Moisture Susceptibility
- Rutting
  - Asphalt Pavement Analyzer
  - 64°C

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Draindown AASHTO T305-97

- A sample of mix is placed in a basket made of ¼" mesh
- Place basket in an oven at estimated production temperatures for 1 hour
- Draindown = Mass of binder that has drained off the aggregate

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Typical Drain-down – AC Only

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Drain-down with Polymer & Fiber

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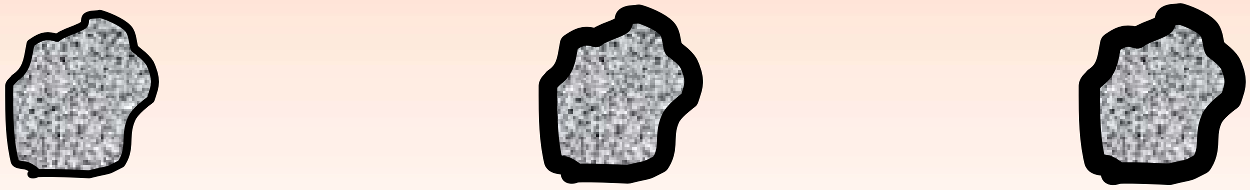
Increased Film Thickness

Dense | Old OGFC | New OGFC

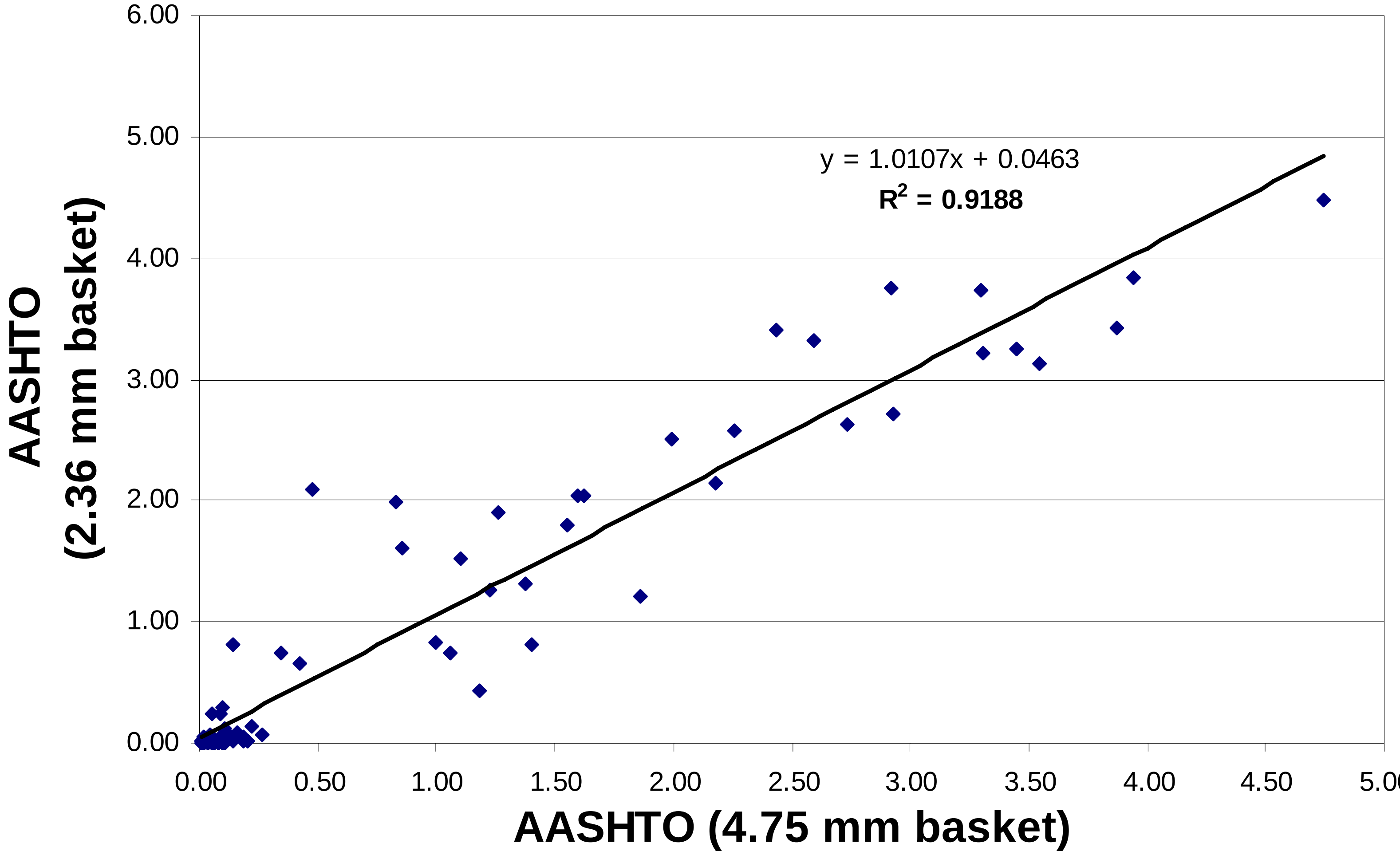


8µm | 25µm | 33µm

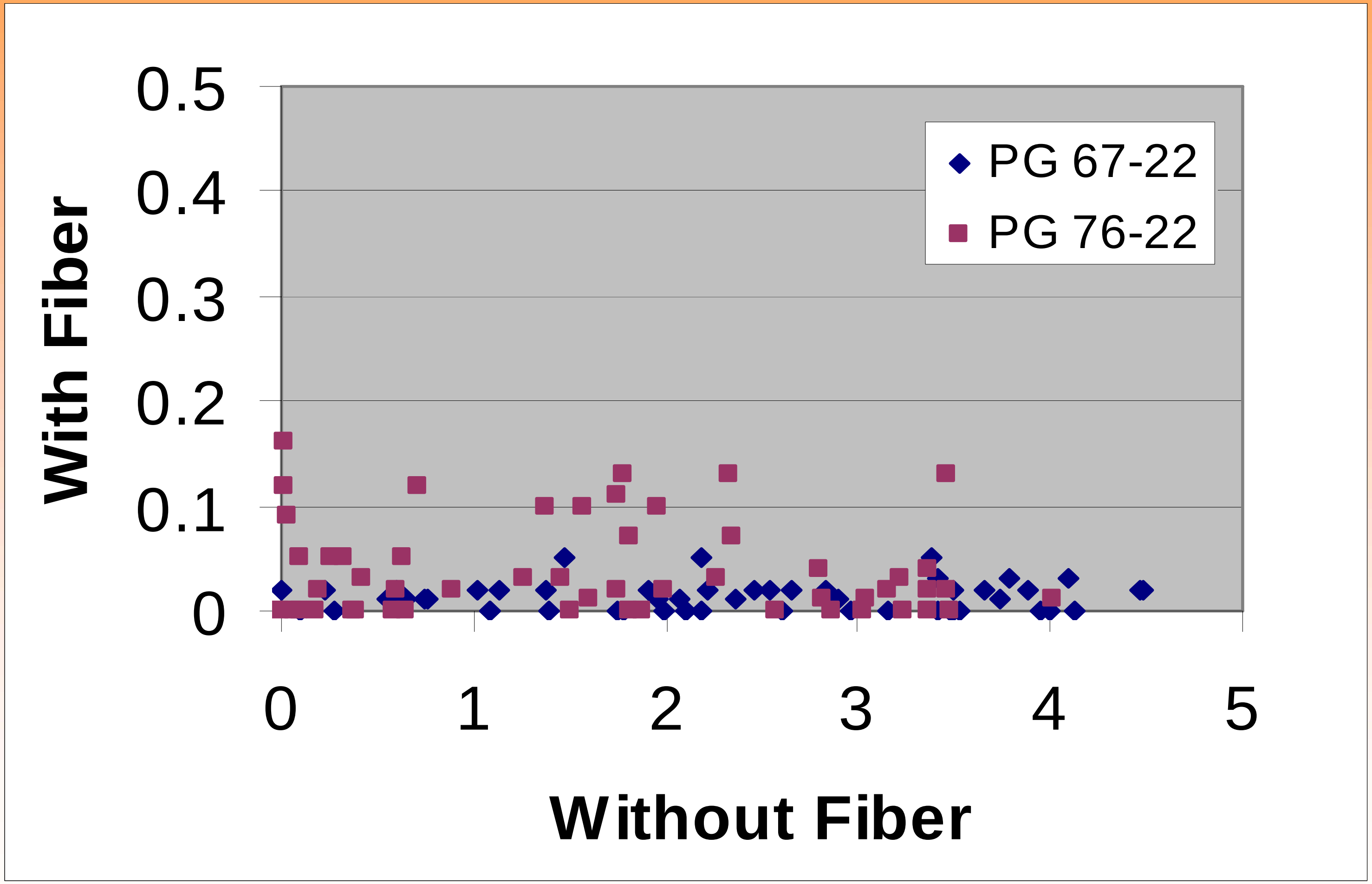
Draindown

- There are concerns that ¼" mesh may be too large for finer mixes
- A smaller mesh size was investigated

Draindown (percent)



Effect of Fiber and PG on Draindown



Conclusions - Draindown

- The repeatability of the draindown test was improved by using the 2.36 mm (No. 8) wire mesh rather than the standard 4.75 mm (No. 4) mesh
- The addition of fiber stabilizers was the most significant factor in reducing binder draindown

Cantabro Test – Stone Loss

Traprock – 3 Samples
Pg 67-22 @ 6.0%

Before

After

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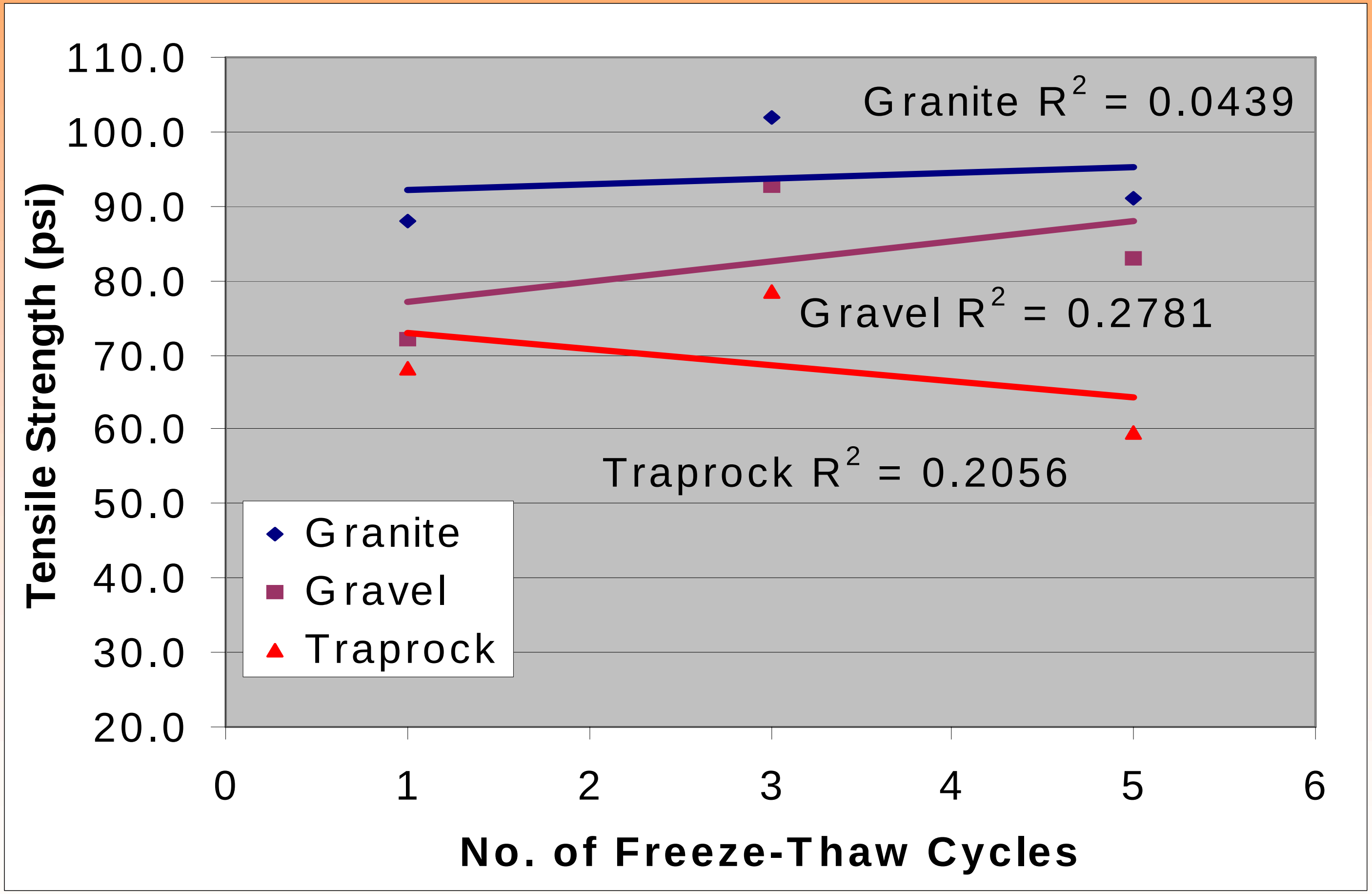
Traprock @ 6.0% PG 76-22

Conclusions - Cantabro

- The Cantabro test appears to be a good method for evaluating the cohesiveness and durability of OGFC mixes
- No significant difference in Marshall (100 mm) and SGC (150 mm) Cantabro results
- Polymer-modified asphalt and rubberized asphalt significantly improves the performance of OGFC mixtures as determined by the Cantabro test

Tensile Strength after 1, 3, 5 Freeze-Thaw Cycles



Permeability

Permeability Results - Granite

Gradation	Binder	AC(%)	Perm. (m/day)
fine	67-22	6	66.8
fine	76-22	6	70.8
fine	76-34	6	45.2
medium	67-22	6	68.3
medium	76-22	6	135.2
medium	76-34	6	49.9
coarse	67-22	6	141.6
coarse	76-22	6	136.6
coarse	76-34	6	108

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Permeability Results

- Dependent on Gradation
- Dependent on Aggregate Type (Gsb)
- Within Lab Std. Dev. – 22.76 m/day

Mix Design Requirements

- VCAmix < VCA DRC
- Minimum Air Voids
  - 16 % CoreLok
  - 18 % Dimensional
- Maximum 20 % Cantabro Loss
- Maximum 0.3 % Draindown
- AASHTO T283
  - 1 Freeze/Thaw cycle
  - 80% TSR *minimum*
- Minimum Permeability – 100 m/day (Coarse OGFC Only)

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Tack Coat

- Rate – 0.06-0.1 gal/sy

Typical Rolling Pattern

Breakdown	2 Coverages - Static
Final	2 Coverages - Static

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Noise Reduction

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How Would You Design A Quiet Pavement ?

Summary of Data

Surface	Average	Low	High
PCC	101	97	106
AC	98	93	101
SMA	97	93	100
Nova Chip	98	95	99
OFGC – C	97	95	98
OGFC - F	95	92	98

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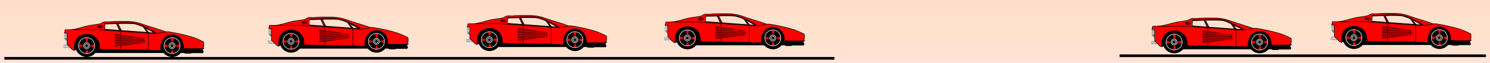
Noise Reduction - OGFC
Effect of -3dB(A)



Equivalent to 1/2 the Intensity

Test Section Layout

North Tangent

	N 5	N 6	N 7	N 8	N 9
Layer 1 (1 ¼ inches)	AZ OGFC	AZ OGFC	AZ OGFC	PEM	PEM
Layer 2 (1 ¼ inches)	Track	AZ OGFC	PEM	PEM	Track

South Tangent

	S 4	S 5	S 6	S 7	S 8
Layer 1 (1¼ inches)	< 4.75 SMA	4.75 SMA	9.5 SMA	4.75 DGA	9.5 DGA
Layer 2	Track				

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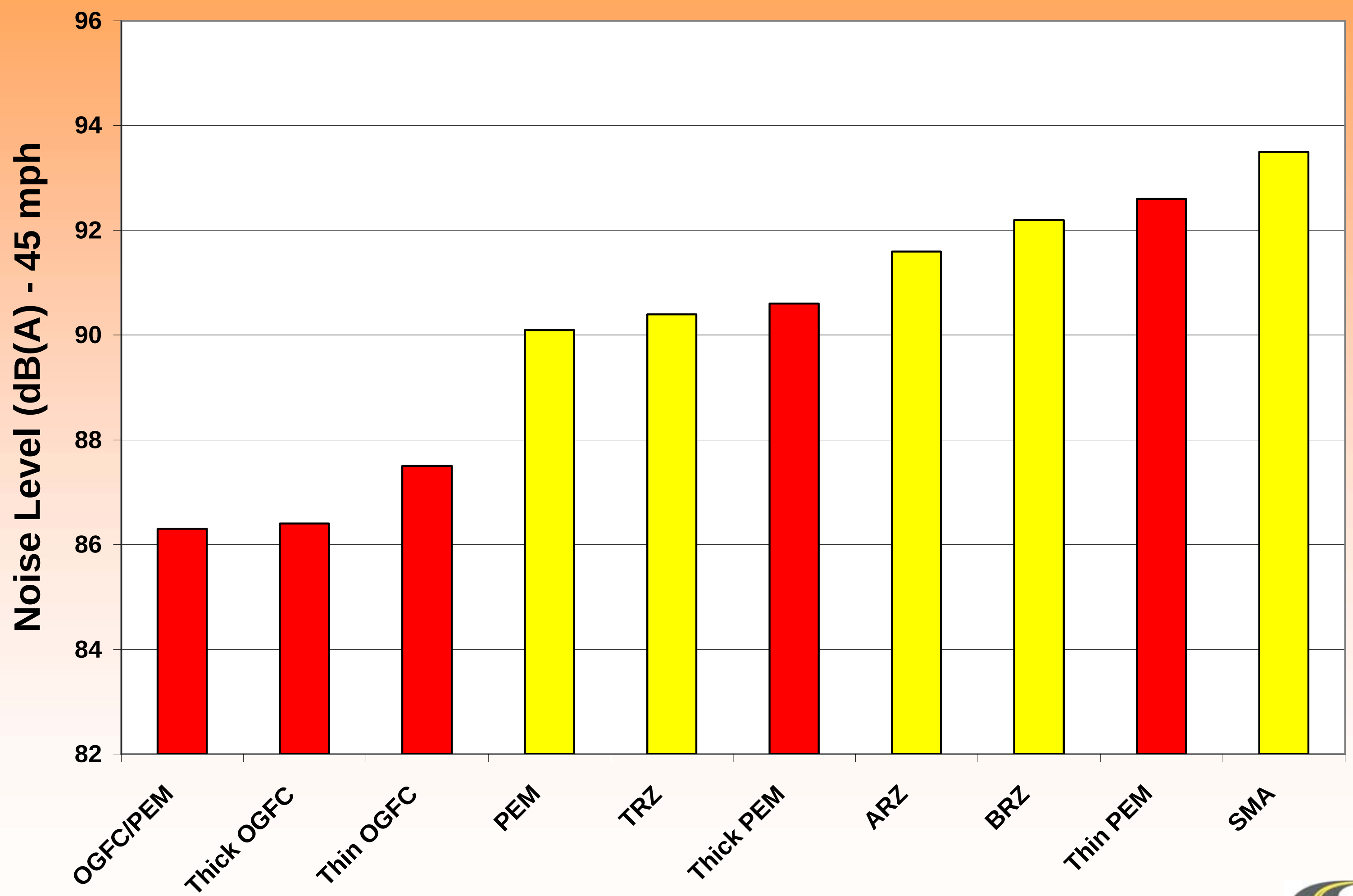
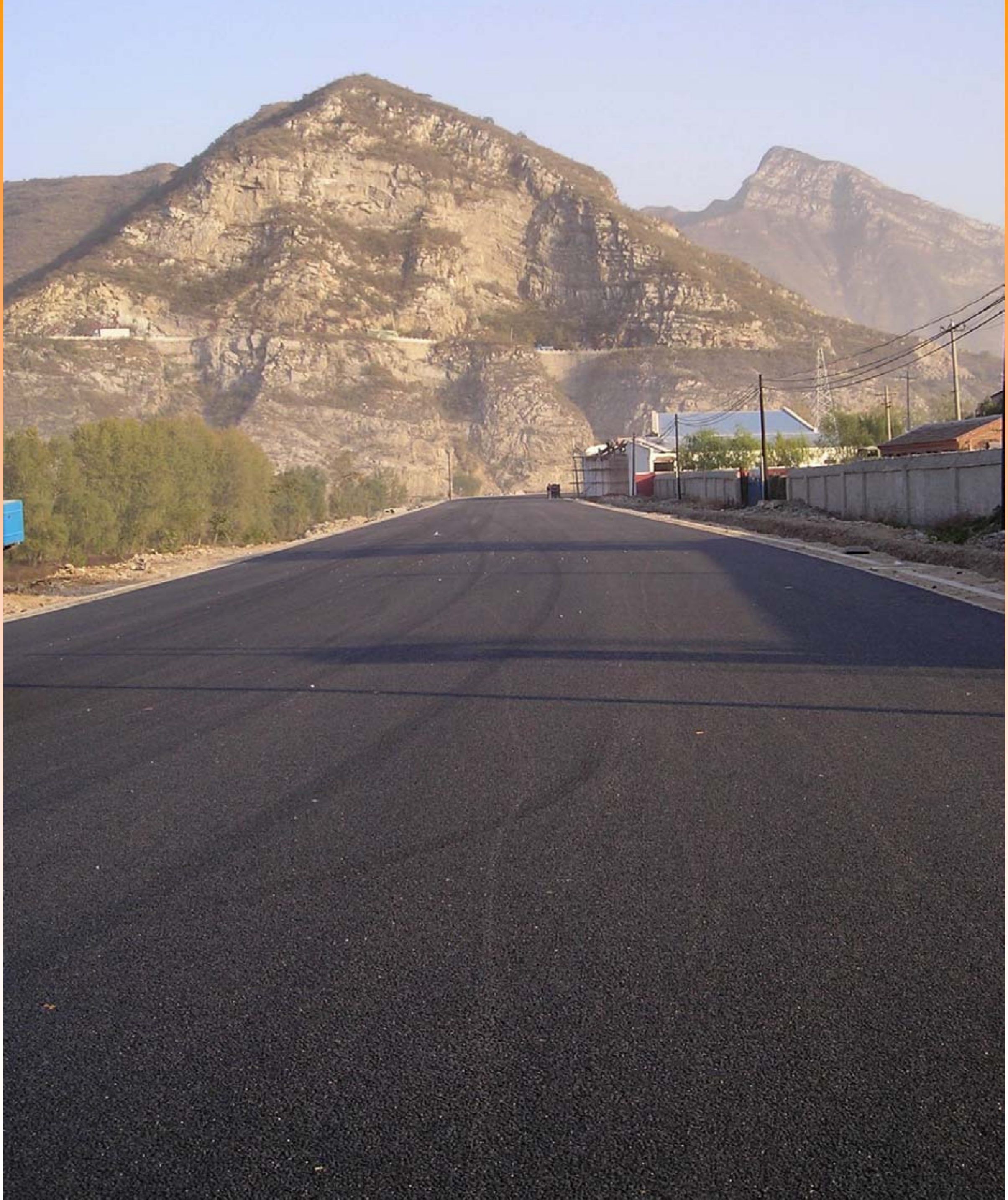
Comparison of Surface Texture

Comparison of Surfaces





QUESTIONS ???