Involvement of University Transportation Centers in Pavement Preservation Research

The University of Oklahoma

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Co-workers:

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University Transportation Centers (UTC)

- About 60 UTCs in the country
  - National, Regional, Tier 1, Tier 2
- Oklahoma Transportation Center (OkTC)
  - A National UTC ($3.5M/year for 5 years)
  - OSU, OU and LU partner institutions
  - Strong partnership with ODOT, OTA and industry
- Research Focus Areas of OkTC
  - ***Transportation Infrastructure Stewardship***
  - (1) Bridge (2) Pavement
  - (3) Freight (4) Safety
  - Education, Diversity and Technology Transfer

Education, Diversity, Tech Transfer

OkTC Seminar at ODOT

Summer Interns

Transportation Research

Pavement Project Examples

Continuous Real-time Measurement of Pavement Quality during Construction
PI: S. Commuri, The University of Oklahoma

Unsaturated Soil Moisture Drying and Wetting Diffusion Coefficient Measurements in the Laboratory
PI: R. Bulut, Oklahoma State University

Effect of Suction Hysteresis on Resilient Modulus of Fine-Grained Soils
PI: G.A. Miller, The University of Oklahoma

Evaluation of Construction Strategies for PCC Pavements
PI: David Jeong, Oklahoma State University

Assessment of Warm Mix Asphalt as a Construction Material
Team: Musharraf Zaman (OU), Steve Cross (OSU), Sharon Lewis (LU)

Pavement Project Examples

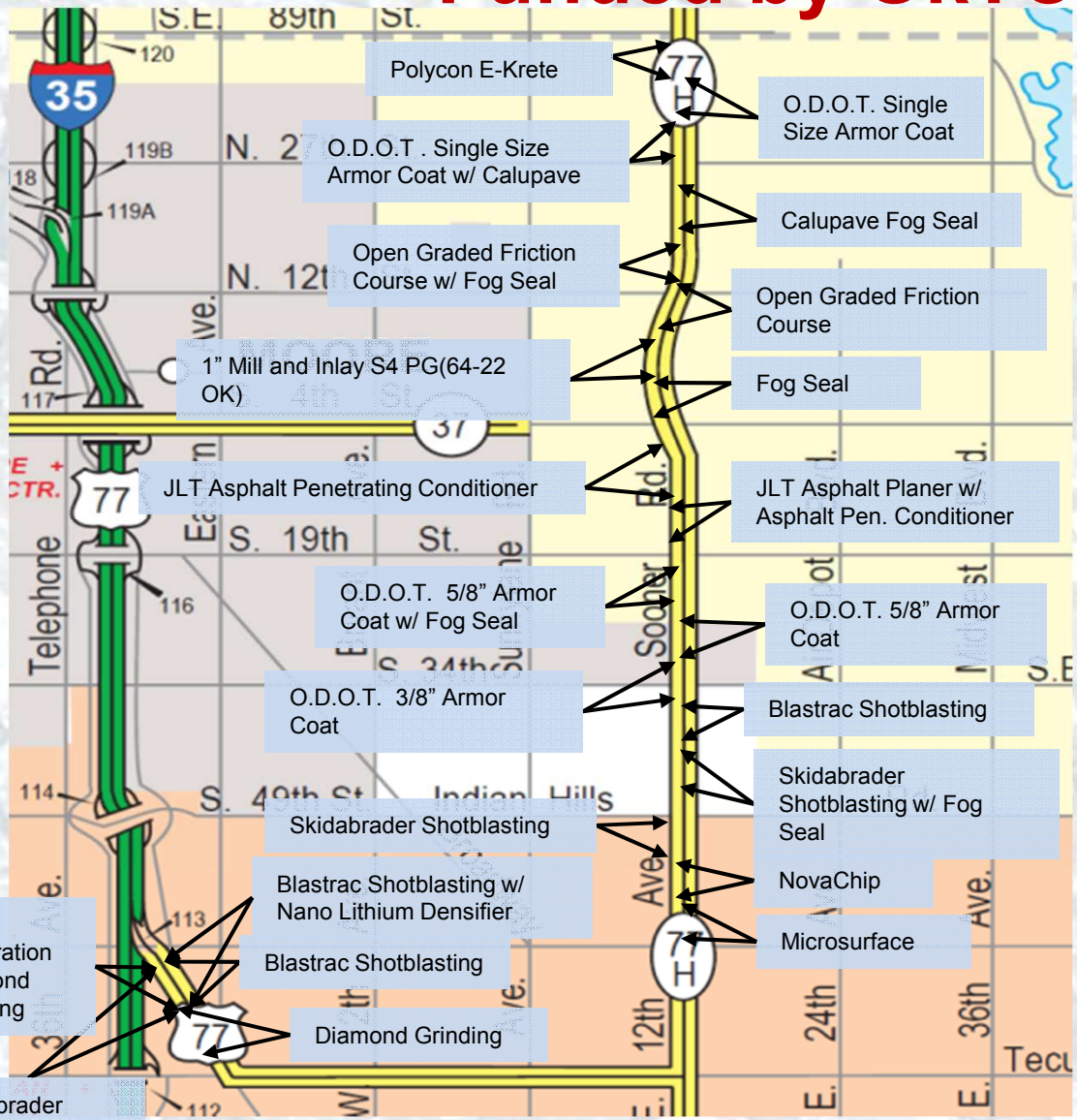
Quantifying the Costs and Benefits of Pavement Retexturing as a Pavement Presernation Tool

Phase I: Construction of Test Sections

Phase II: Performance Monitoring

Pavement Preservation Guidelines					
	Type of Activity	**Increase Capacity**	**Increase Strength**	**Reduce Aging**	**Restore Serviceability**
	New Construction	X	X	X	X
	Reconstruction	X	X	X	X
	Major Rehabilitation		X	X	X
	Structural Overlay		X	X	X
Pavement Preservation	Minor Rehabilitation			X	X
	Preventive Maintenance			X	X
	Routine Maintenance				X
	Corrective (Reactive) Maintenance				X
	Catastrophic Maintenance				X

Pavement Preservation Project Funded by OkTC



Research Team:
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Dominique Pittenger

- 23 TEST SECTIONS
- ¼ MILE LONG (400 M)

ASPHALT SECTIONS

- 12 Surface Treatments
- 2 Chemical Treatments
- 4 Mechanical Treatments

CONCRETE SECTIONS

Test Section Sponsors

- Blastrac, Inc. Edmond, OK
- Penhall Diamond Grinding, Anaheim, CA
- JLT Corp. Cushing, OK
- Ergon Emulsions and Materials, Austin, TX
- Skidabrader, Inc. Ruston, LA
- Polycon, Madison, MS
- Haskell Lemon & Hall Brothers, OKC, OK
- Pathway Services, Tulsa, OK
- Calumet Lubricants, Shreveport, LA

J.L.T. Corporation

Flat Headed Mill with Asphalt Penetrating Conditioner

Polycon

E-Krete

Blastrac

Asphalt & Concrete Shot Blasting

Skidabrader

Concrete & Asphalt Shot Blasting with Fog Seal

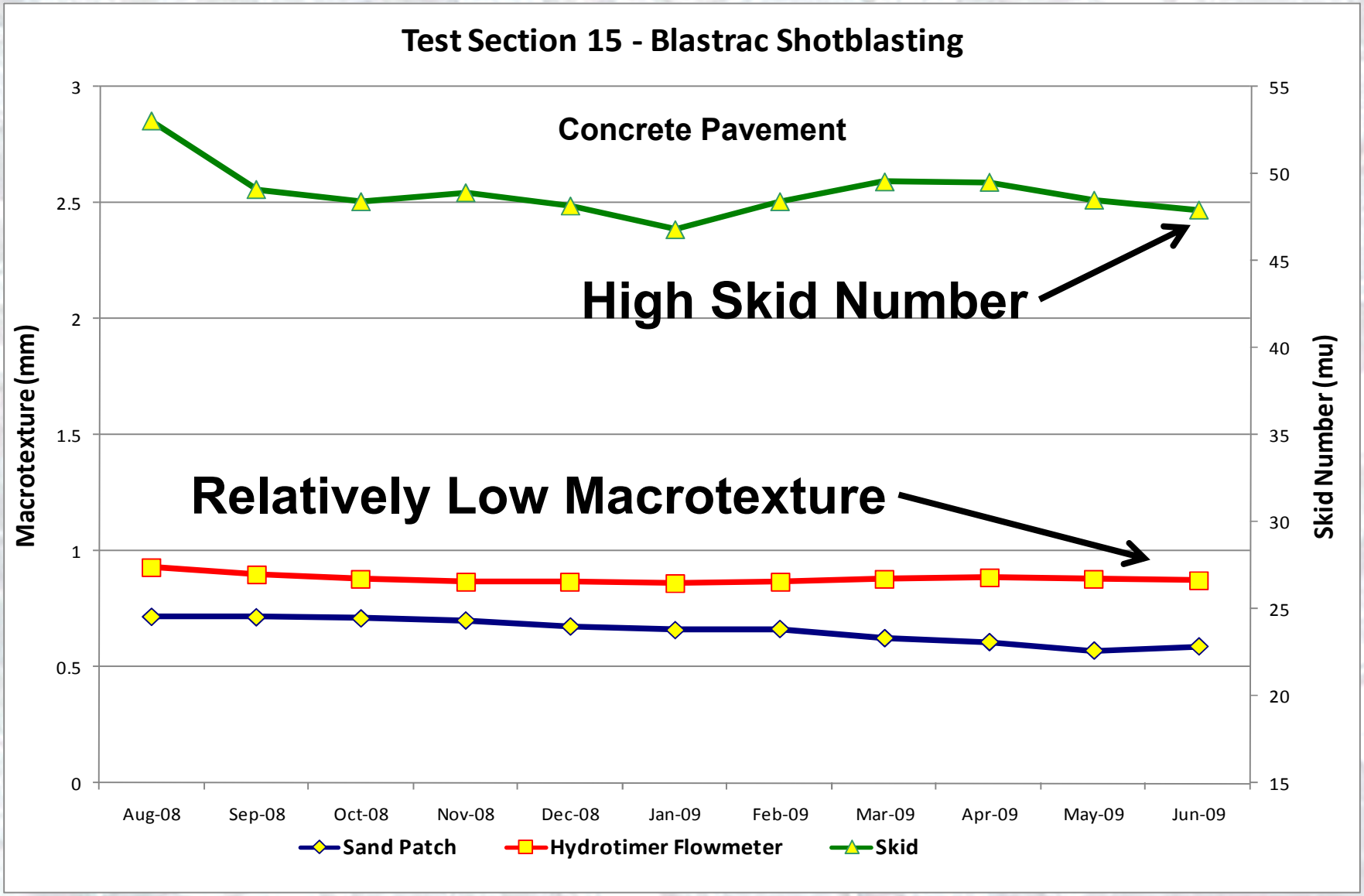
Testing Protocol

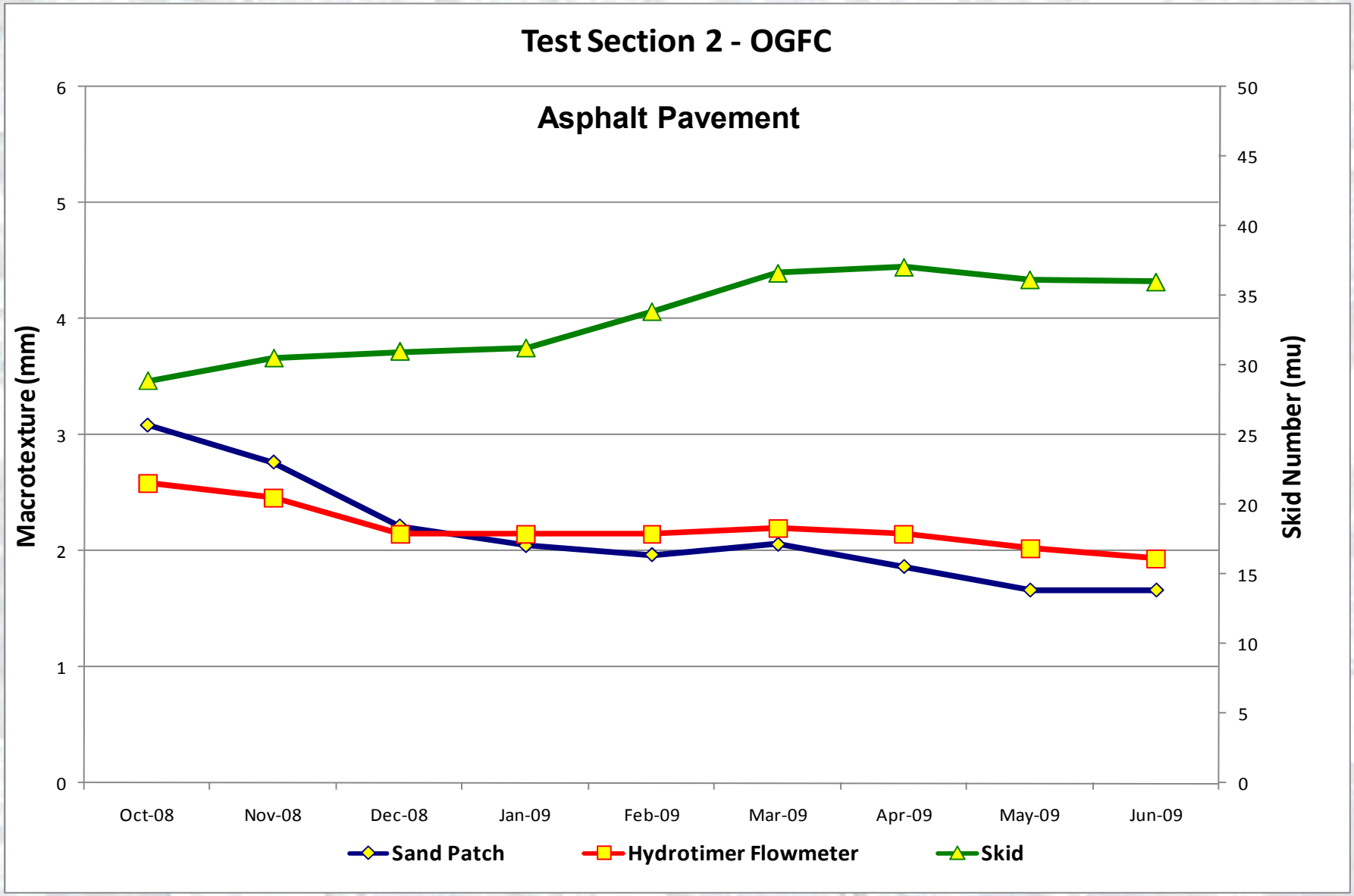
- Follow change in macrotexture & skid resistance over time.
- Macrotexture tests
  - ASTM STP 583 Outflow meter
  - TNZ T/3 Sand circle
  - TNZ P/17 Performance Spec for chip seal texture
  - RoboTex (Transtec)
  - High Speed Truck Mounted Laser (Pathway)
- Skid resistance measured by ODOT skid tester
  - Ribbed tire (40 mph) & Smooth tire (40 mph and 55 mph)
- Test conducted monthly for 3 years
- Plans to extend period to surface failure, but will reduce frequency to quarterly tests

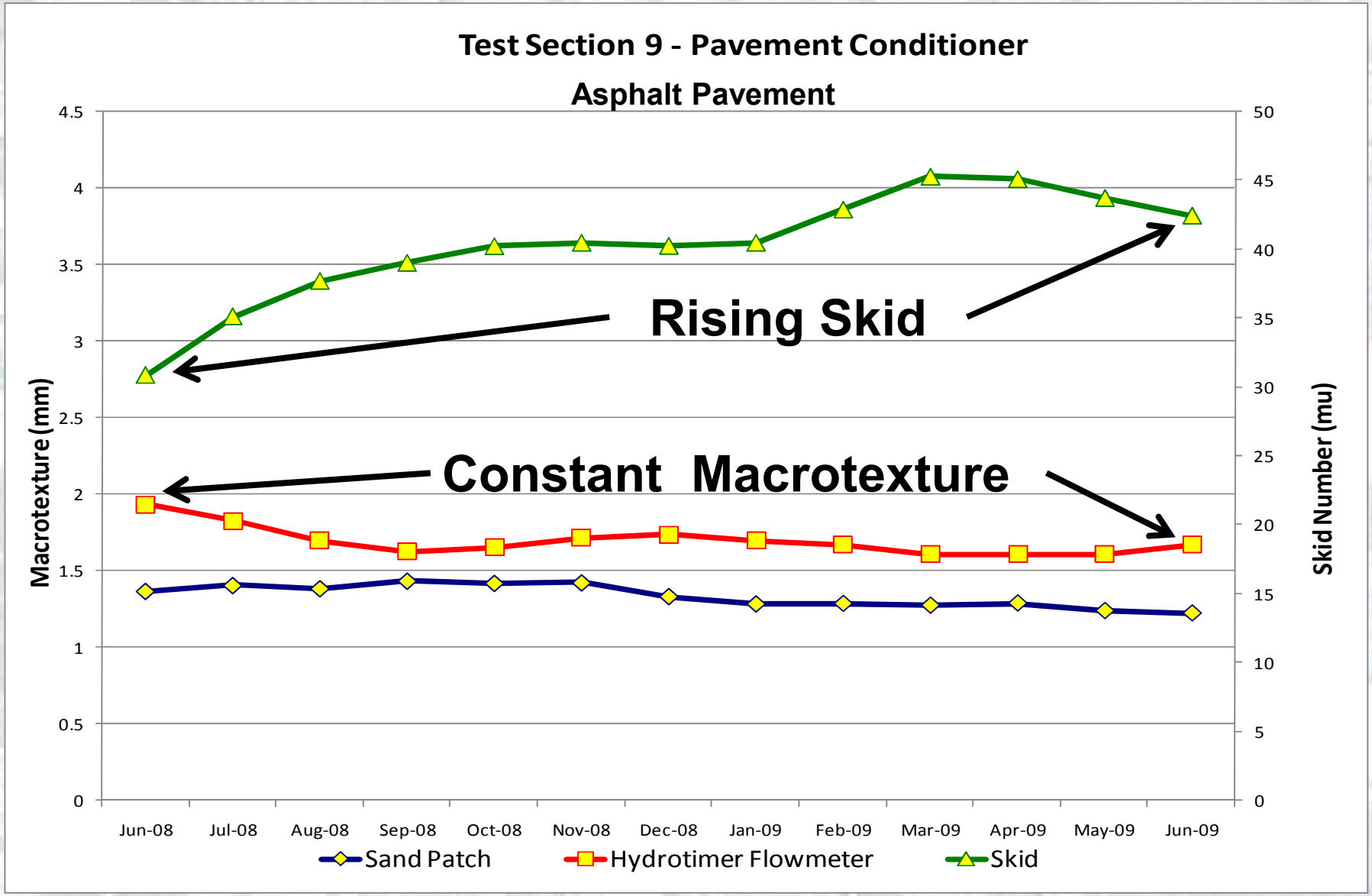
Macrotexture Testing

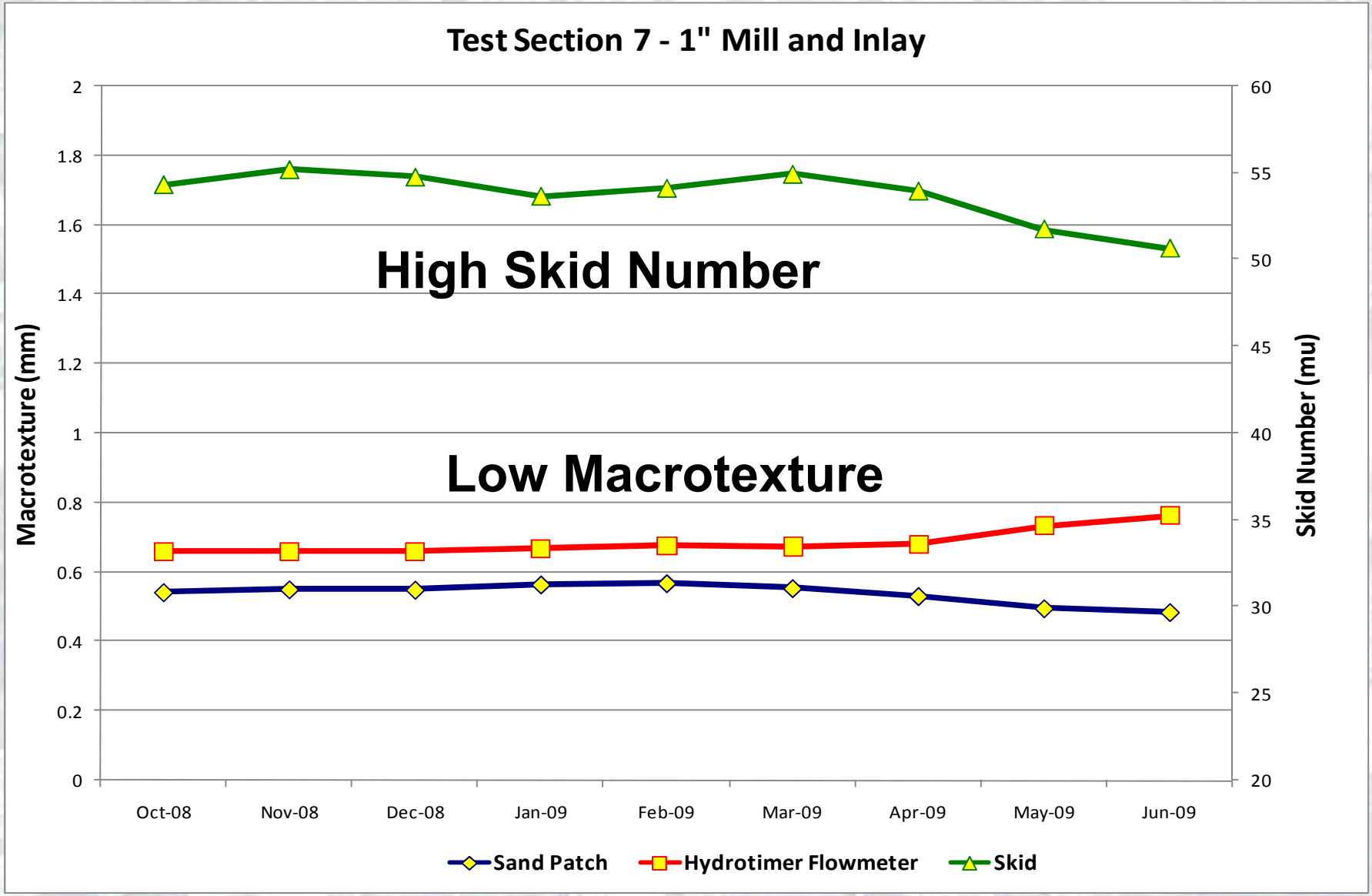
TNZ T3 Sand Circle

Hydrotimer Outflow Meter

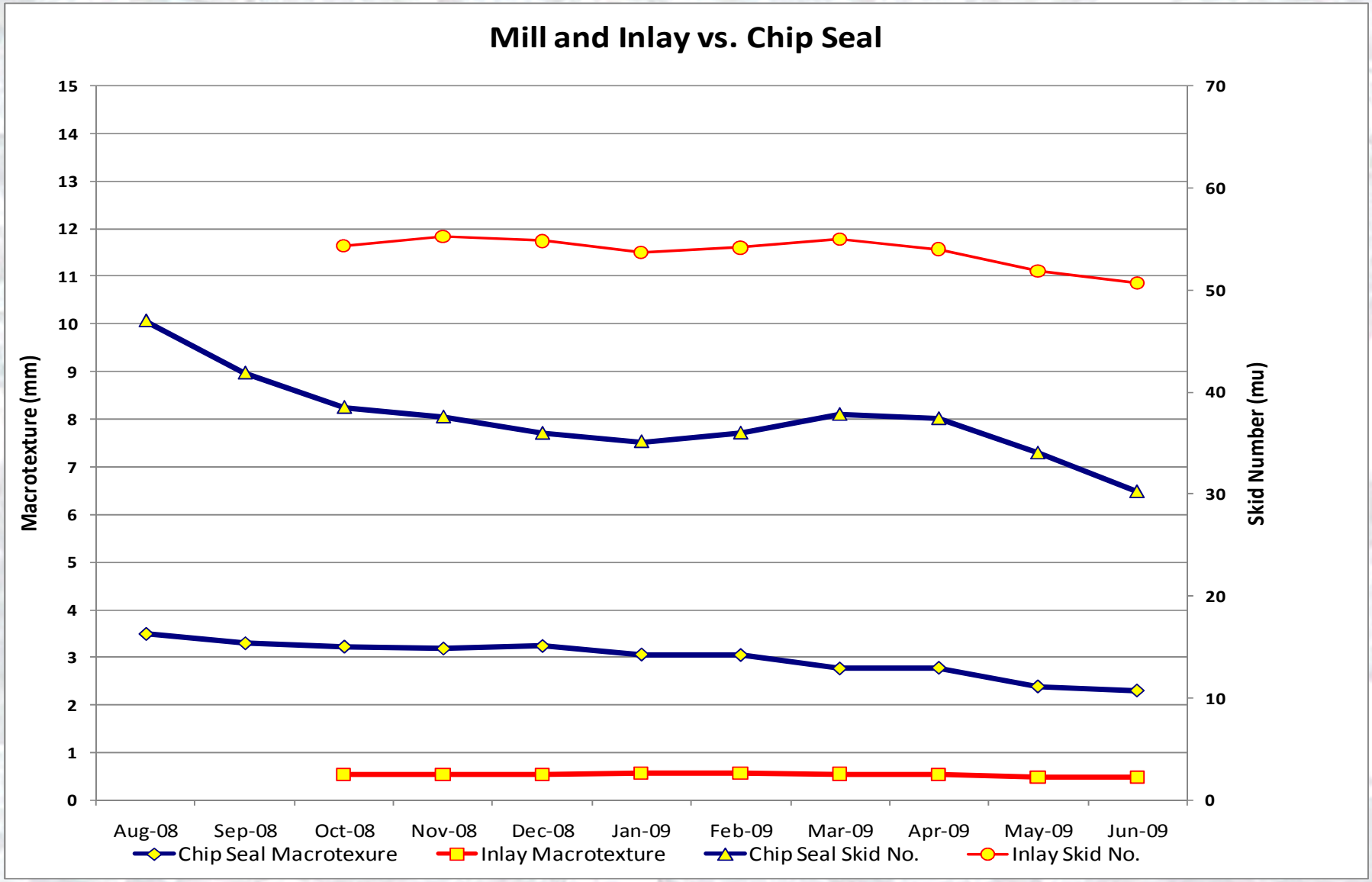

Test Section 15 - Blastrac Shotblasting
Concrete Pavement
High Skid Number
Relatively Low Macrotexture
Macrotexture (mm)
Skid Number (mu)
3
2.5
2
1.5
1
0.5
0
55
50
45
40
35
30
25
20
15
Aug-08
Sep-08
Oct-08
Nov-08
Dec-08
Jan-09
Feb-09
Mar-09
Apr-09
May-09
Jun-09
Sand Patch
Hydrotimer Flowmeter
Skid


Test Section 2 - OGFC
Asphalt Pavement
Macrotexture (mm)
Skid Number (mu)
0
1
2
3
4
5
6
0
5
10
15
20
25
30
35
40
45
50
Oct-08
Nov-08
Dec-08
Jan-09
Feb-09
Mar-09
Apr-09
May-09
Jun-09
Sand Patch
Hydrotimer Flowmeter
Skid


Test Section 9 - Pavement Conditioner
Asphalt Pavement
Rising Skid
Constant Macrotexture
Macrotexture (mm)
Skid Number (mu)
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
50
45
40
35
30
25
20
15
10
5
0
Jun-08
Jul-08
Aug-08
Sep-08
Oct-08
Nov-08
Dec-08
Jan-09
Feb-09
Mar-09
Apr-09
May-09
Jun-09
Sand Patch
Hydrotimer Flowmeter
Skid


Test Section 7 - 1" Mill and Inlay
High Skid Number
Low Macrotexture
Macrotexture (mm)
Skid Number (mu)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
60
55
50
45
40
35
30
25
20
Oct-08
Nov-08
Dec-08
Jan-09
Feb-09
Mar-09
Apr-09
May-09
Jun-09
Sand Patch
Hydrotimer Flowmeter
Skid

Comparing Treatment Alternatives



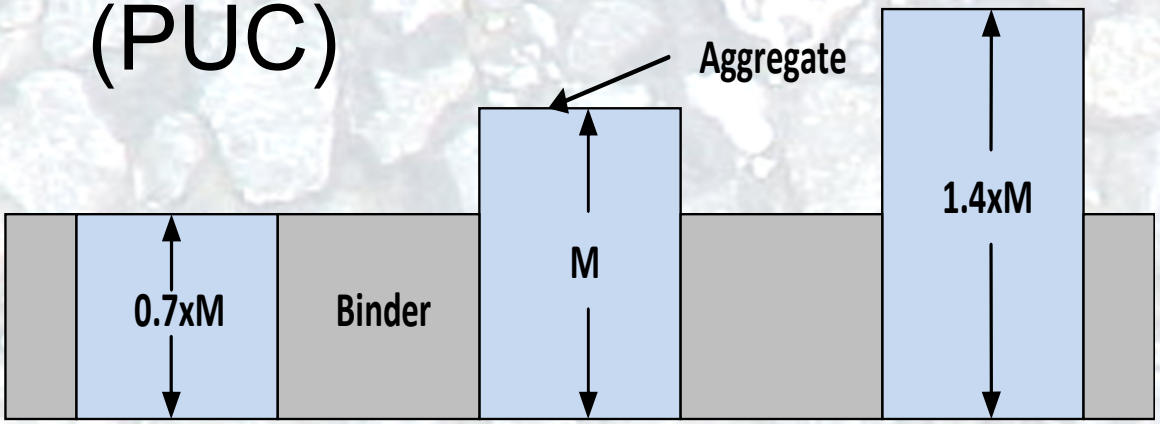
Chip Seal Failures

- Short term (within one year)
  - Aggregate-binder (emulsion) incompatibility
  - Excessive fines
  - Construction deficiency (inadequate rolling, time of construction)
- Long-term failure
  - Loss of macro-texture (flushing/bleeding)
  - Loss of skid resistance
- Cover aggregate spec
  - Gradation (PUC-based gradation)
  - Aggregate shape and texture
- Aggregate-binder compatibility
  - Characterize adhesion based on surface-free energy

Bleeding (%) = P_{EM} (1) Aggregate loss (%) = 100 – P_{2EM} (2)

Aggregate Gradation

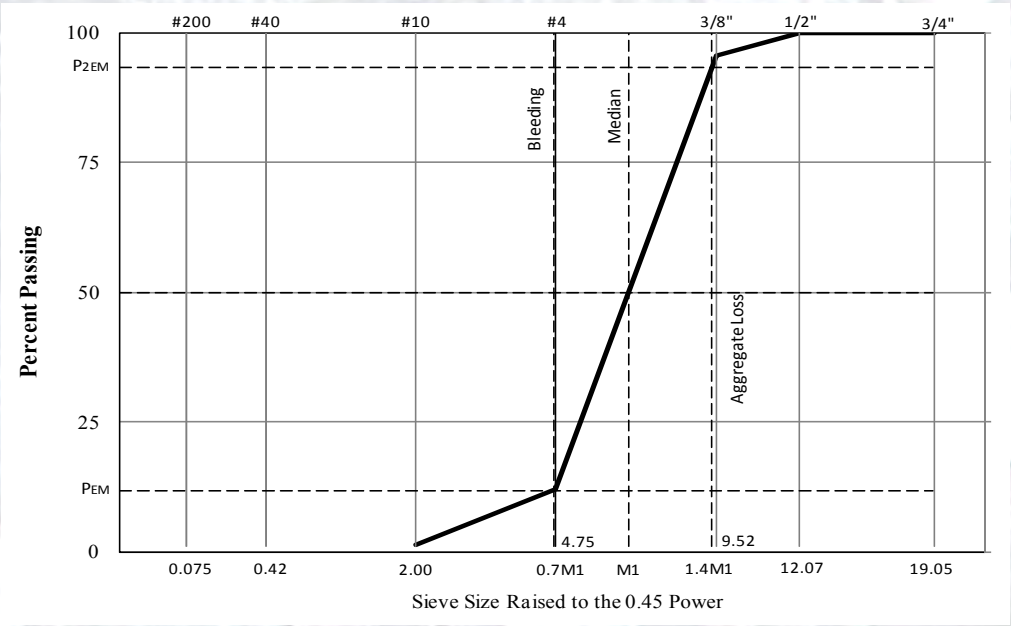
- Performance-based Uniformity Coefficient (PUC)



Bleeding (%) = P_{EM} (1)

Aggregate loss (%) = 100 – P_{2EM} (2)

P_{EM} = percent passing at a given embedment depth of the median particle size, EM



Bleeding (%) = P_{1EM} = 100 – P_1 (1) Aggregate loss (%) = 100 – P_{2EM} (2)

Aggregate Gradation

- Performance-based Uniformity Coefficient (PUC)

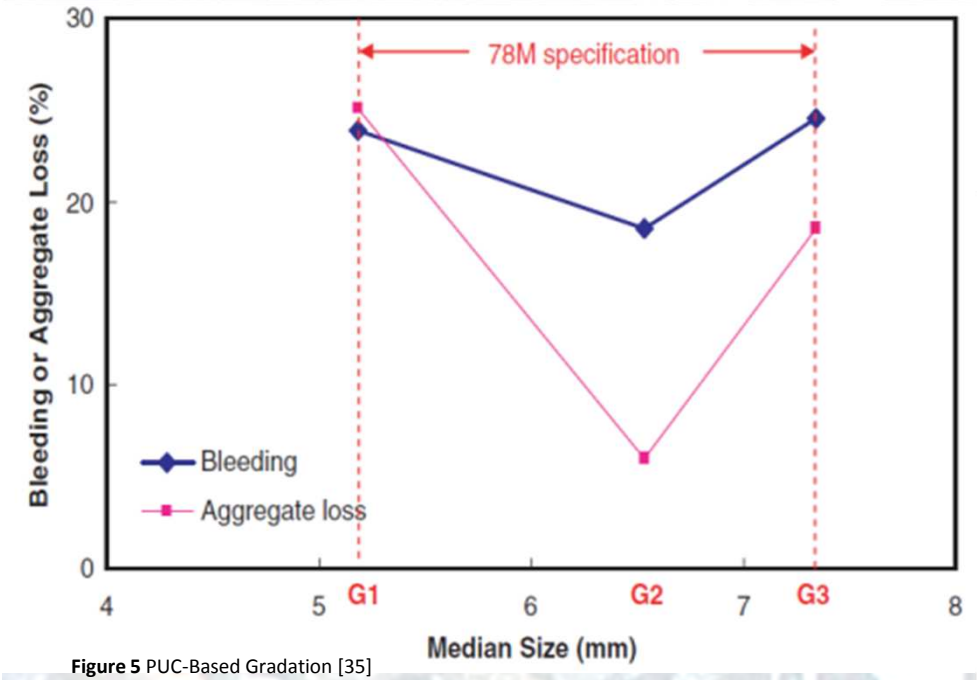
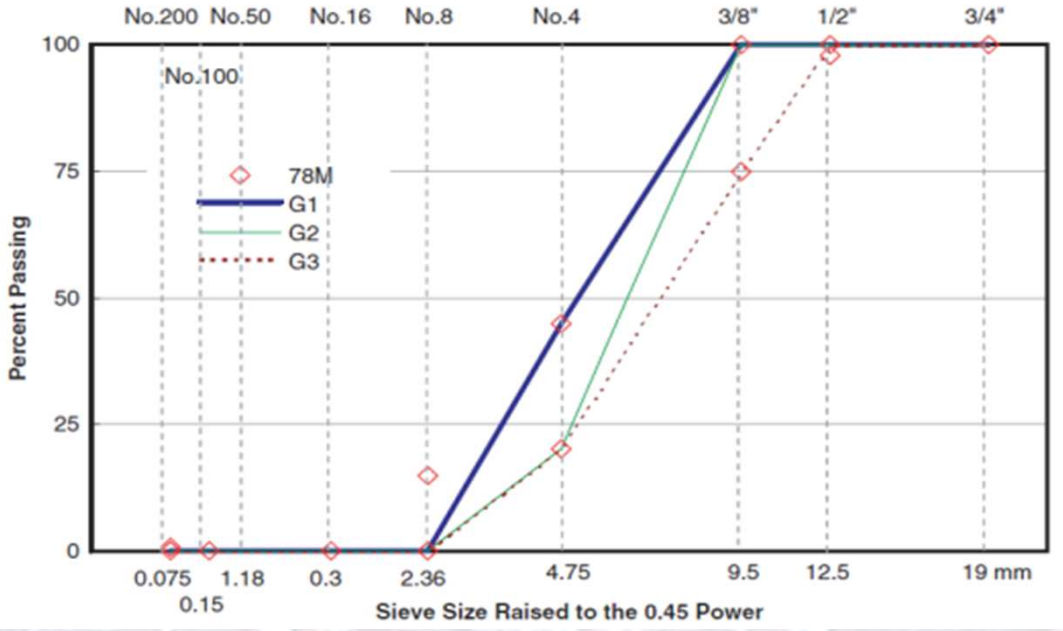
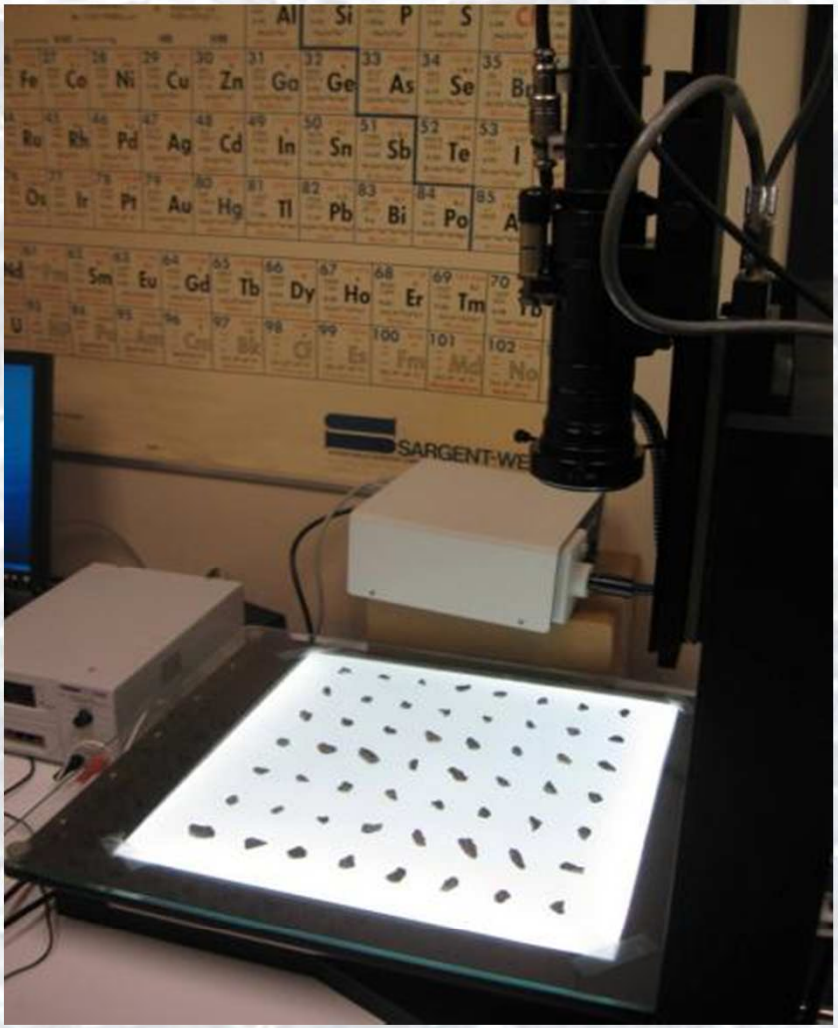


Figure 5 PUC-Based Gradation [35]



Li and Kim, North Carolina



AGGREGATE IMAGING SYSTEM

Shape and texture

- 2D form
- Angularity (gradient and radius)
- Spericity
- Texture

Material	Cationic emulsion	Anionic emulsion
Electropositive materials (calcium, basalt) 	Neutralizing reaction ▼ BREAKING forming of insoluble amine carbonate ▼ ADHESIVENESS	attraction ▼ BREAKING forming of insoluble calcium soap ▼ ADHESIVENESS
Electronegative materials (silex, quartz, granite) 	attraction ▼ BREAKING forming of insoluble amine silicate ▼ ADHESIVENESS	no neutralizing reaction ▼ no attraction

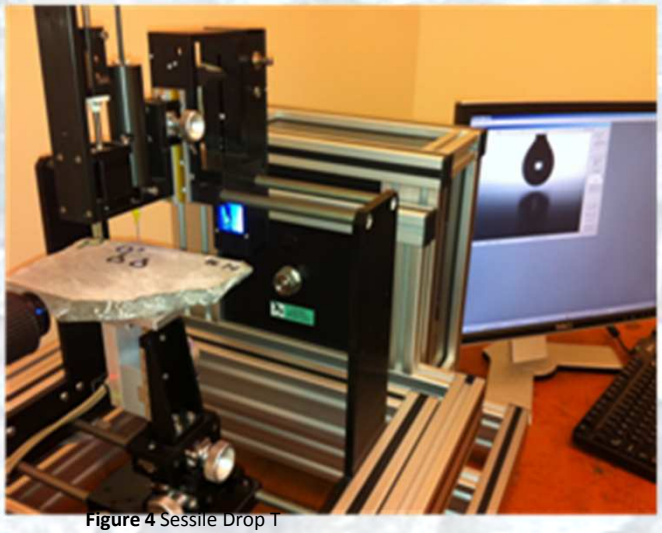


Figure 4 Sessile Drop T

Sessile Drop Device

Aggregate-Binder Compatibility

- Measure contact angles with liquids of known surface free energy
- Determine "compatibility ratio"
  - Free energy of adhesion under dry condition (ΔG^a_{dry}) / free energy of adhesion in the presence of moisture (ΔG^a_{wet})

Economic Analysis

- Tracking change in engineering properties must be correlated with an analysis of the cost of supplying those properties
- Life cycle cost analysis for each tested alternative.
- Develop life cycle cost model for pavement texture over time.
- Use of Cost Index Number Theory to quantify “Bang for the Buck”

Pavement Preservation

Questions????

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