Dispute Resolution

National Pavement Preservation Conference

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Marriott Hotel
Nashville, TN

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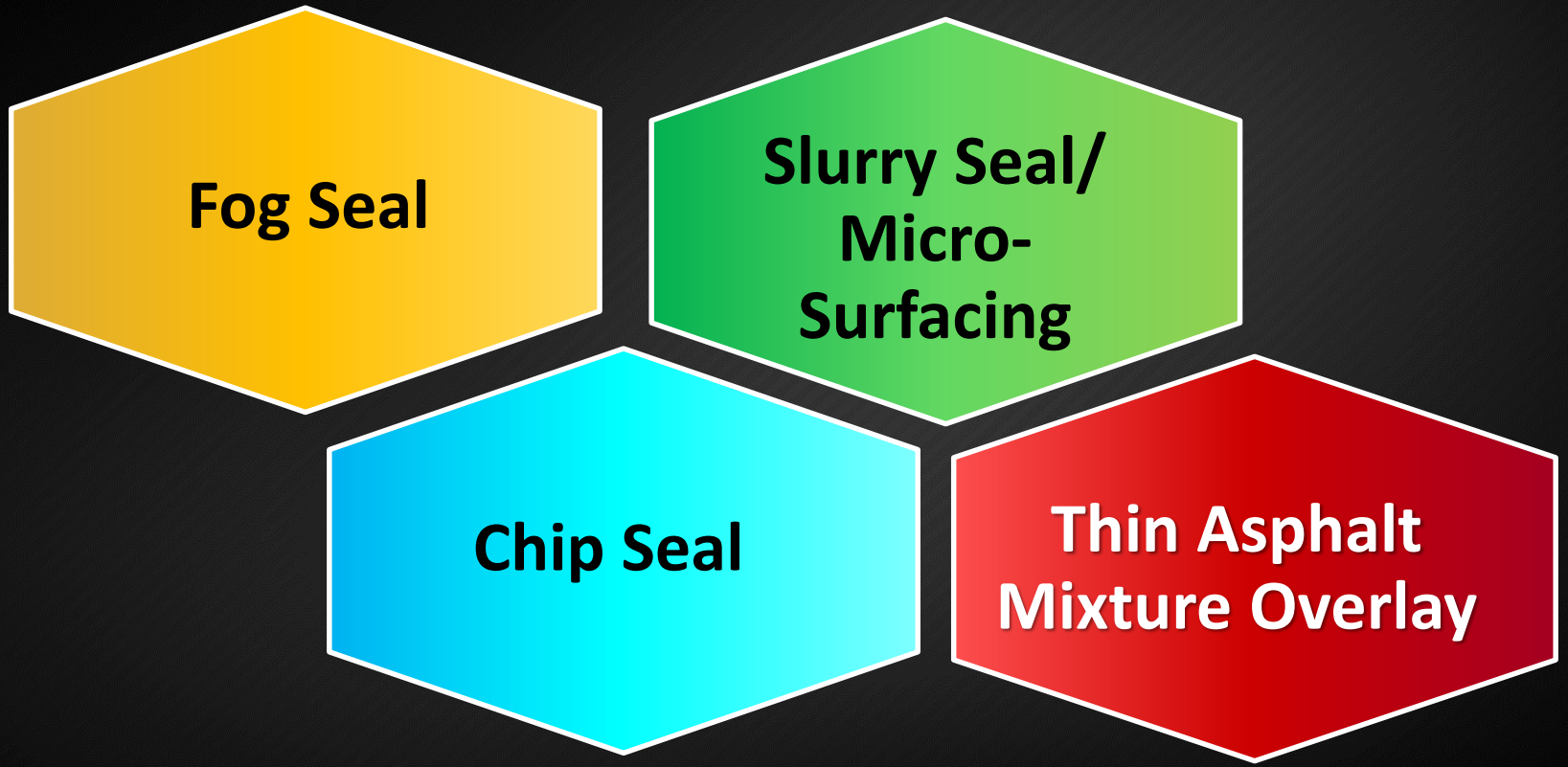
Outline

- **Introduction**
- Key Activities & Measurements
- Variability
- Sampling Variability
- Testing Variability
- Materials/Construction Variability
- Summary

Introduction

- Pavement Preservation Alternatives
- Common Disputes
- Resolution

Pavement Preservation Alternatives



Common Disputes

- QC/QA Test Results (Comparisons)
- Job Mix Formula (Approval/Changes)
- Change Materials (Aggregates/Binders)
- Performance (Premature Distress)

Resolution

- Address Likely Issues Prior to Construction
- Public Agency/Contractor/Material Supplier
  - Resolve Recurring Issues
  - Pre-construction Meeting
  - Specifications – Address Dispute Resolution
  - Meetings/Information Exchange
- Performance Warranty
- Third Party
- Legal

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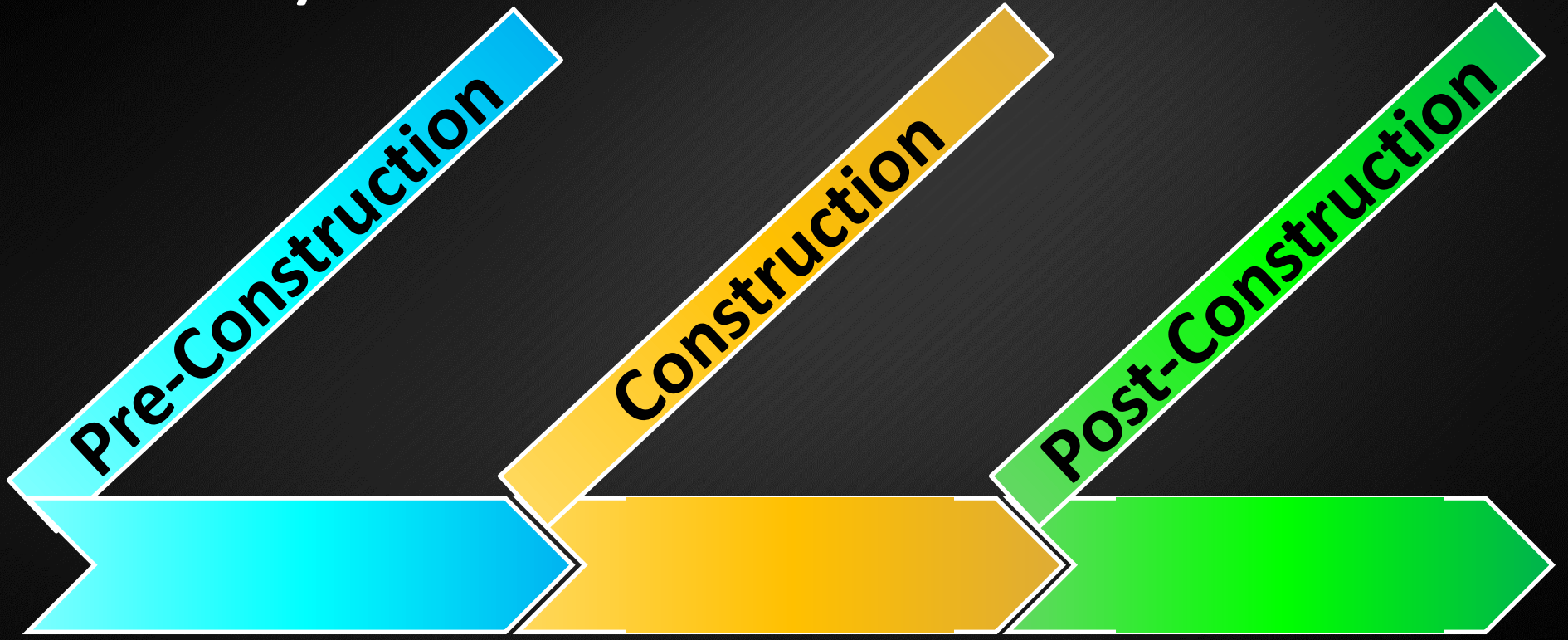
Key Activities & Measurement



Pre-Construction

- Mixture Design
  - Aggregate Properties
  - Binder Properties
  - Additive Properties
  - Mixture Properties
  - Proportions (Job Mix Formula)
  - Verification
- Equipment Calibration
- Laboratory Accreditation
- Personnel Certification

Construction

- Process Control Tests
- Quality Control Tests
- Quality Assurance Tests
- Independent Assurance Tests
- Certifications
- Inspection
- Quality Management System

Post-Construction

- Measurement & Payment
- Final Acceptance
- Performance (Warranty)

Pre-Construction		Construction
Job Mix Formula	→	Job Mix Formula
Material Properties	→	Material Properties
Mixture Properties	→	Mixture Properties
		Quality Control
		Quality Assurance

Post Construction Performance

Project Selection

- Type Severity, Extent of Distress
- Thickness Design
- Traffic
- Constraints

Pre-Construction

Construction

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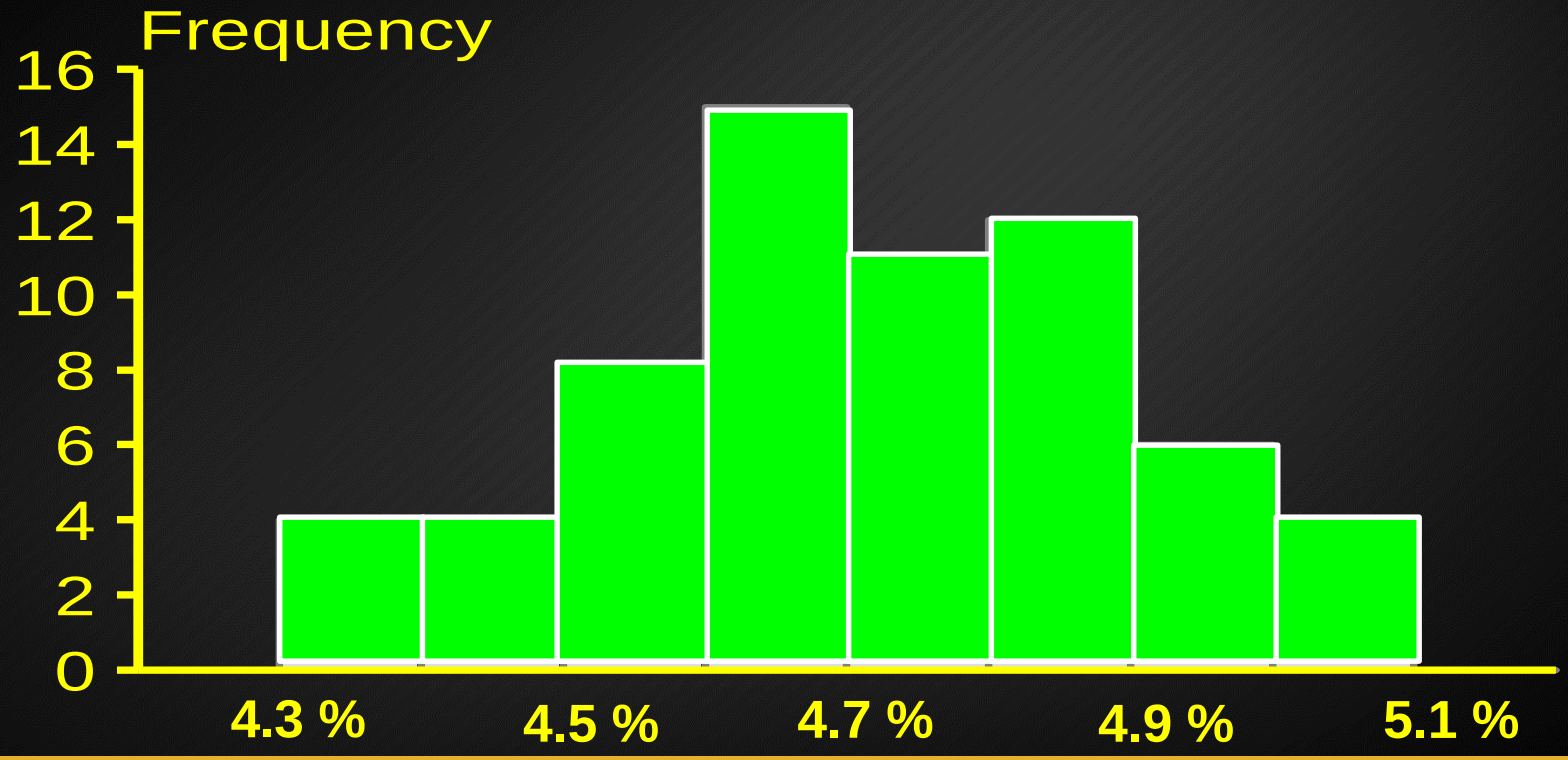
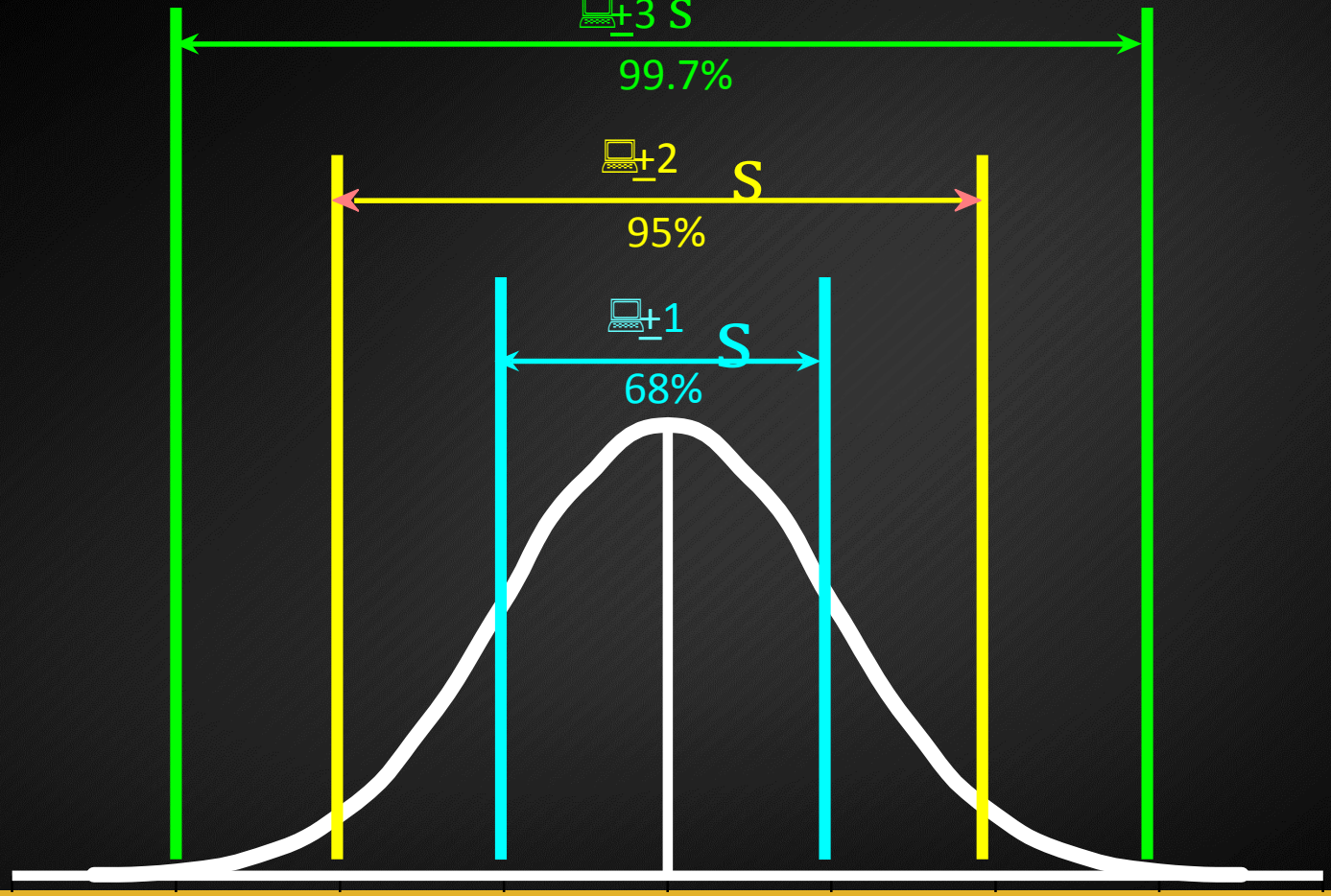
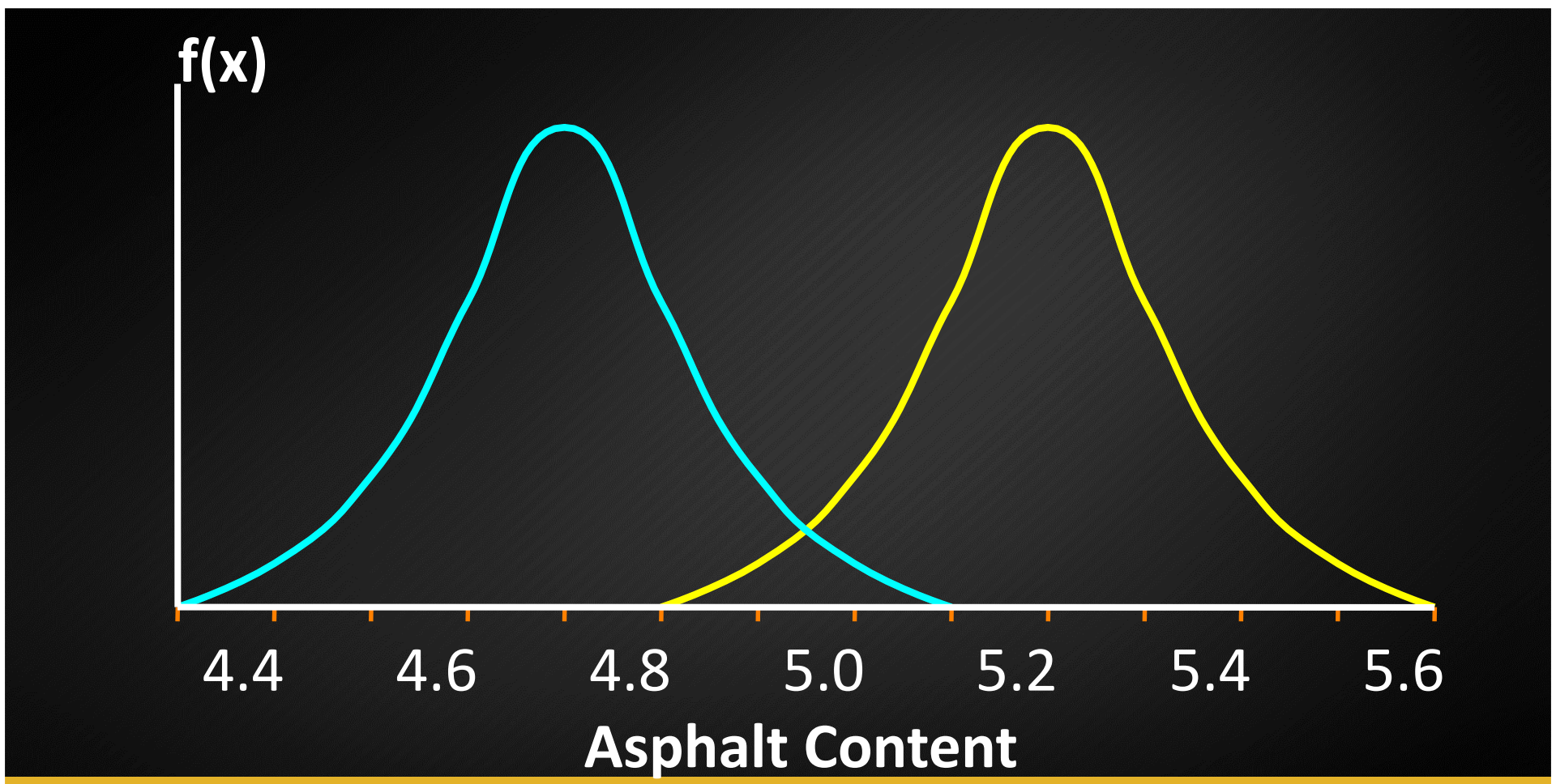
60 Asphalt Binder Contents

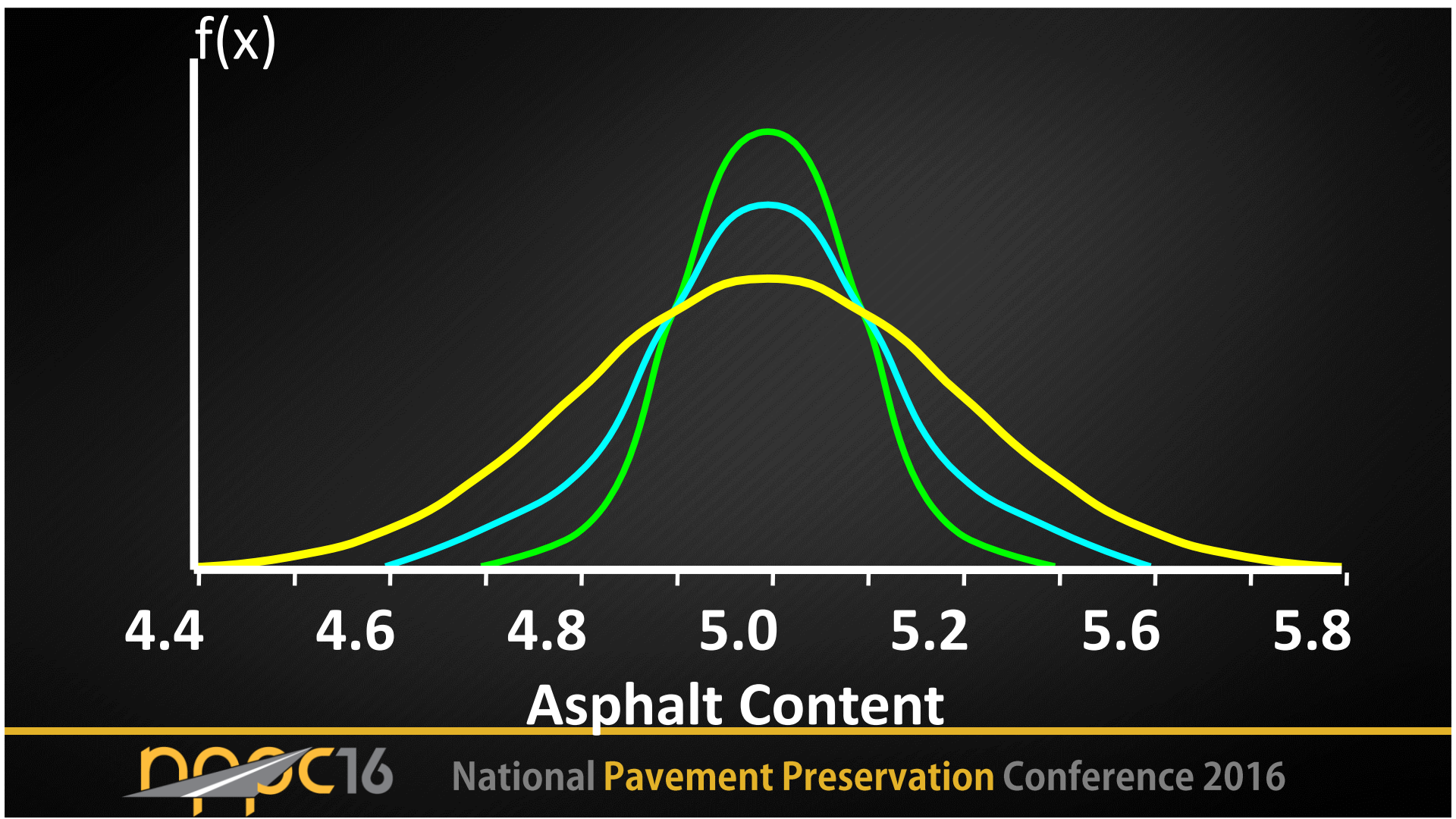


Statistical Representation of Variability

- Mean – $\bar{x}$
- Standard Deviation – s
- Coefficient of Variation – $\frac{s}{x}$


±3 S
99.7%
±2
S
95%
±1
S
68%


f(x)
4.4
4.6
4.8
5.0
5.2
5.4
5.6
Asphalt Content


f(x)
4.4
4.6
4.8
5.0
5.2
5.6
5.8
Asphalt Content

QC/QA and Variability

Variability = variability + variability + variability

(QC/QA) (sampling) (test method) (mat./const.)

$$S^2_{QC/QA} = S^2_s + S^2_t + S^2_{m/c}$$

Sources of Variability

- Sampling - random variation in sampling methods or procedures
- Testing - random variation in testing performance and equipment

Sampling + testing variability = about 50% of the variation in test results

- Material - random natural variation
- Construction - variation inherent in production and construction methods

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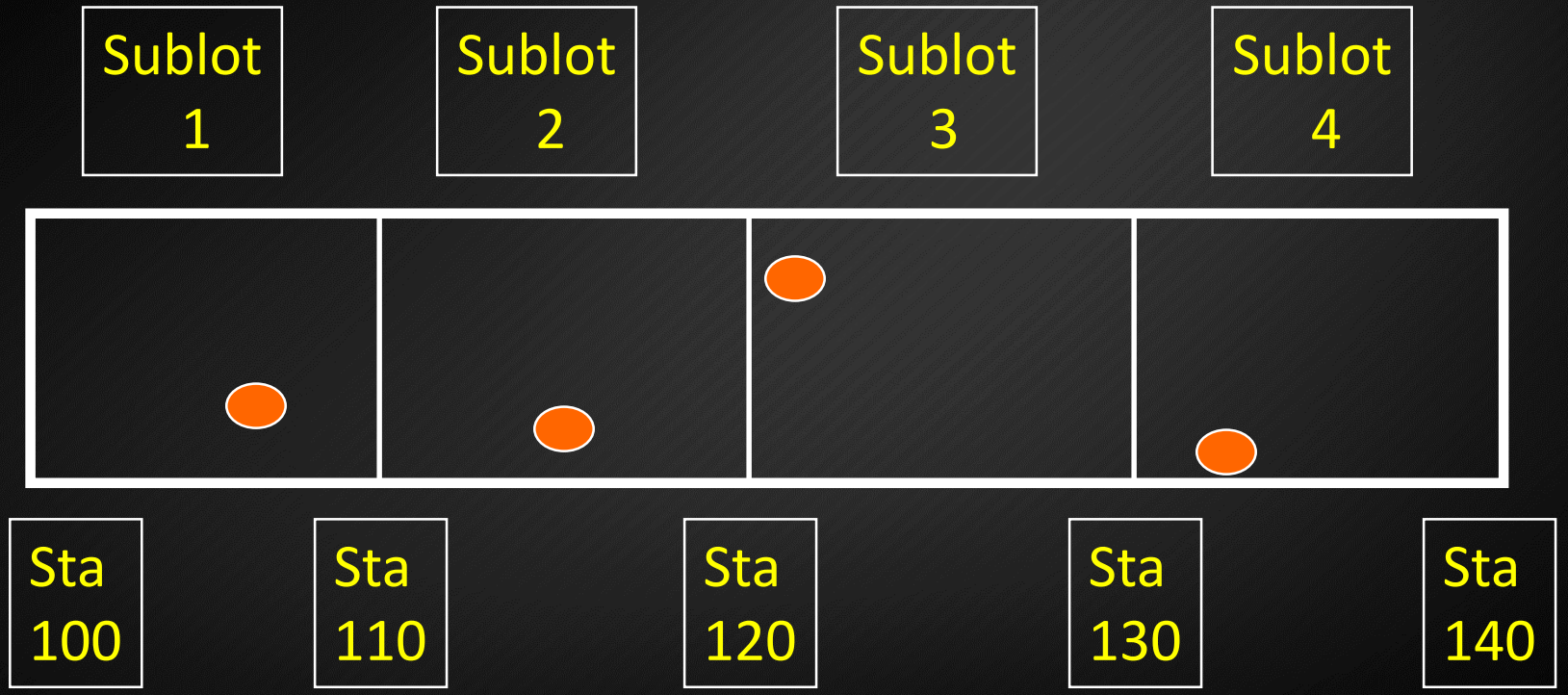
Effect of Number of Samples and Associated Risk

Number of Samples (n)	Contractor's Risk (α)	Owner's Risk (β)
1	0%	84%
1	5%	50%
4	0%	16%
4	5%	2.5%

Stratified Random Sampling



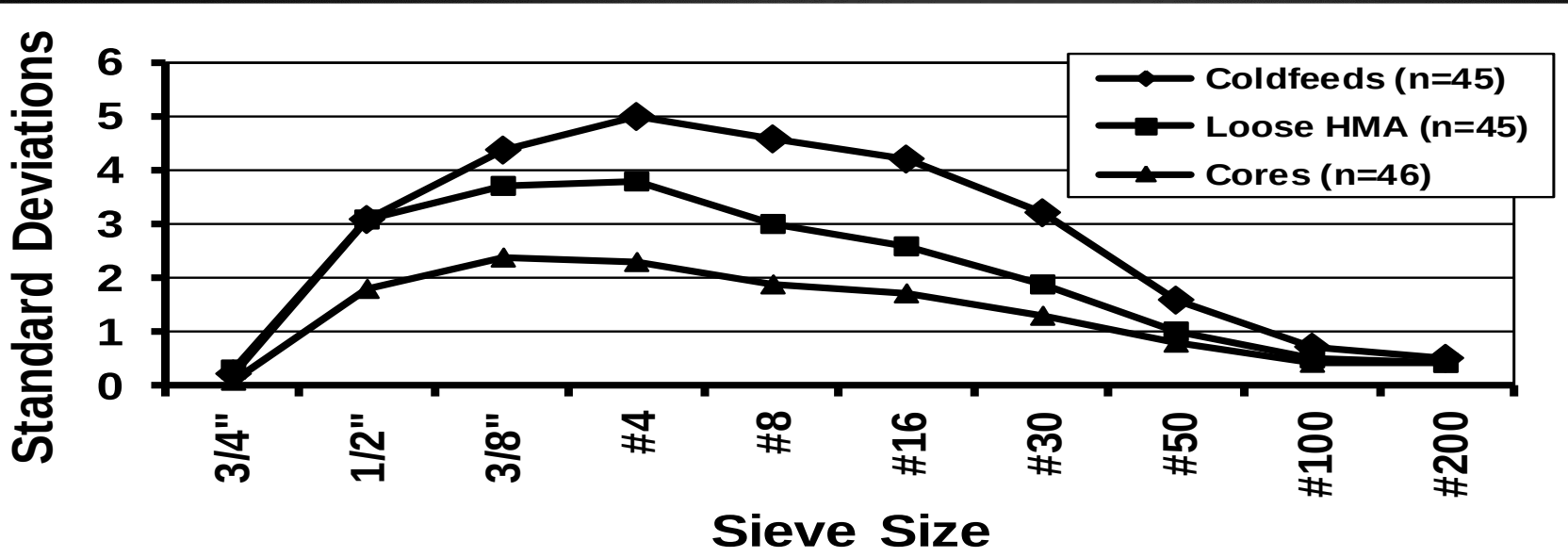
Point of Sampling

- Asphalt
  - Plant Tank or Middle 1/3 of Truck Load
  - Bleed off & Discard Prior to Sampling
  - Sample & Seal

Point of Sampling

- Asphalt Content
  - Loose Plant, Truck, Mat (entire lift), Windrow, or Paver (auger) Samples, Cores
- Aggregate Gradation
  - Coldfeeds or hot bins
  - Extracted from HMA (loose samples or cores)
- Lab Compacted Volumetrics
  - Loose Plant, Truck, Mat (entire lift), Windrow, or Paver (auger) Samples

Effect of Sampling Location on Gradation Variability



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Within Laboratory Precision - (Single Operator Precision)

Designations		Description	Single Operator Precision			
			Standard Deviation (1S)		Acceptable Range of Two Results (D2S)	
AASHTO Method	ASTM Method		AASHTO	ASTM	AASHTO	ASTM
T228	D70	Asphalt Cement Specific Gravity	0.0008	0.0008	0.0023	0.0023
T85	C127	Coarse Aggregate Specific Gravity	0.009	0.009	0.025	0.025
T84	C128	Fine Aggregate Specific Gravity	0.011	0.011	0.032	0.032
T166	D2726	Bulk Specific Gravity of Compacted Bituminous Specimens	*	0.0124	*	0.035
T209	D2041	Theoretical Maximum Specific Gravity of Bituminous Mixture	0.0040 (0.0064)	0.0040 (0.0064)	0.011 (0.018)	0.011 (0.018)

*** - "Duplicate specific gravity results by same operator should not be considered suspect unless differ more than 0.02."**

( ) - supplemental procedure for mixtures containing porous aggregate conditions ("dryback procedure").

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Between Laboratory Precision - (Multilaboratory Precision)

Designations		Description	Multilaboratory Precision			
			Standard Deviation (1S)		Acceptable Range of Two Results (D2S)	
AASHTO Method	ASTM Method		AASHTO	ASTM	AASHTO	ASTM
T228	D70	Asphalt Cement Specific Gravity	0.0024	0.0024	0.0068	0.0068
T85	C127	Coarse Aggregate Specific Gravity	0.013	0.013	0.038	0.038
T84	C128	Fine Aggregate Specific Gravity	0.023	0.023	0.066	0.066
T166	D2726	Bulk Specific Gravity of Compacted Bituminous Specimens	*	0.0269	*	0.076
T209	D2041	Theoretical Maximum Specific Gravity of Bituminous Mixture	0.0064 (0.0193)	0.0064 (0.0193)	0.019 (0.055)	0.019 (0.055)

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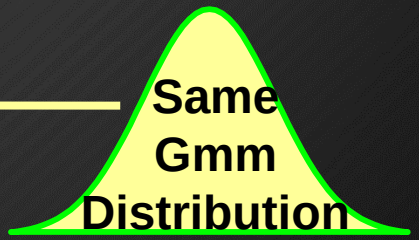
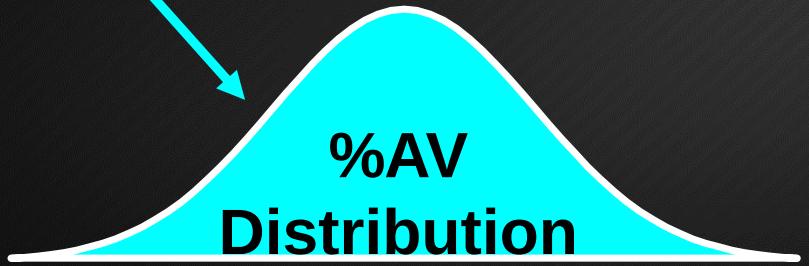
Monte Carlo Simulation

$$\%AV = 100 \times \frac{G_{mm} - G_{mb}}{G_{mm}}$$





G_{mm} and G_{mb} =inputs

%AV = output

Summary and Conclusions

- “Acceptable” Variability Associated with the Measurement of the Properties Required to Determine HMA Volumetrics can Have a Significant Impact on Calculated Volumetric Properties

Summary and Conclusions

- Within Laboratory Test Method Variability May Lead to Differences in AV and VMA of 1.0^{+}% for Any Given Mix Design

- These Differences Translate into Potential Differences of 0.7% in Optimum Asphalt Content Selection

Summary and Conclusions

- Between Laboratory Test Method Variability May Lead to Differences in AV and VMA of over 2.0% for Any Given Mix Design

- These Differences Translate into Potential Differences of Over 1.0% in Optimum Asphalt Content Selection

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Typical Variability

Property	Standard Deviation(s)
Asphalt Content, %	0.25
% pass 4.75 mm, %	3.0
% pass 2.36 mm to 0.15 mm, %	2.0
% pass 0.075 mm, %	0.7
Air Voids, %	1.0
VMA, %	1.5
VFA, %	5.0

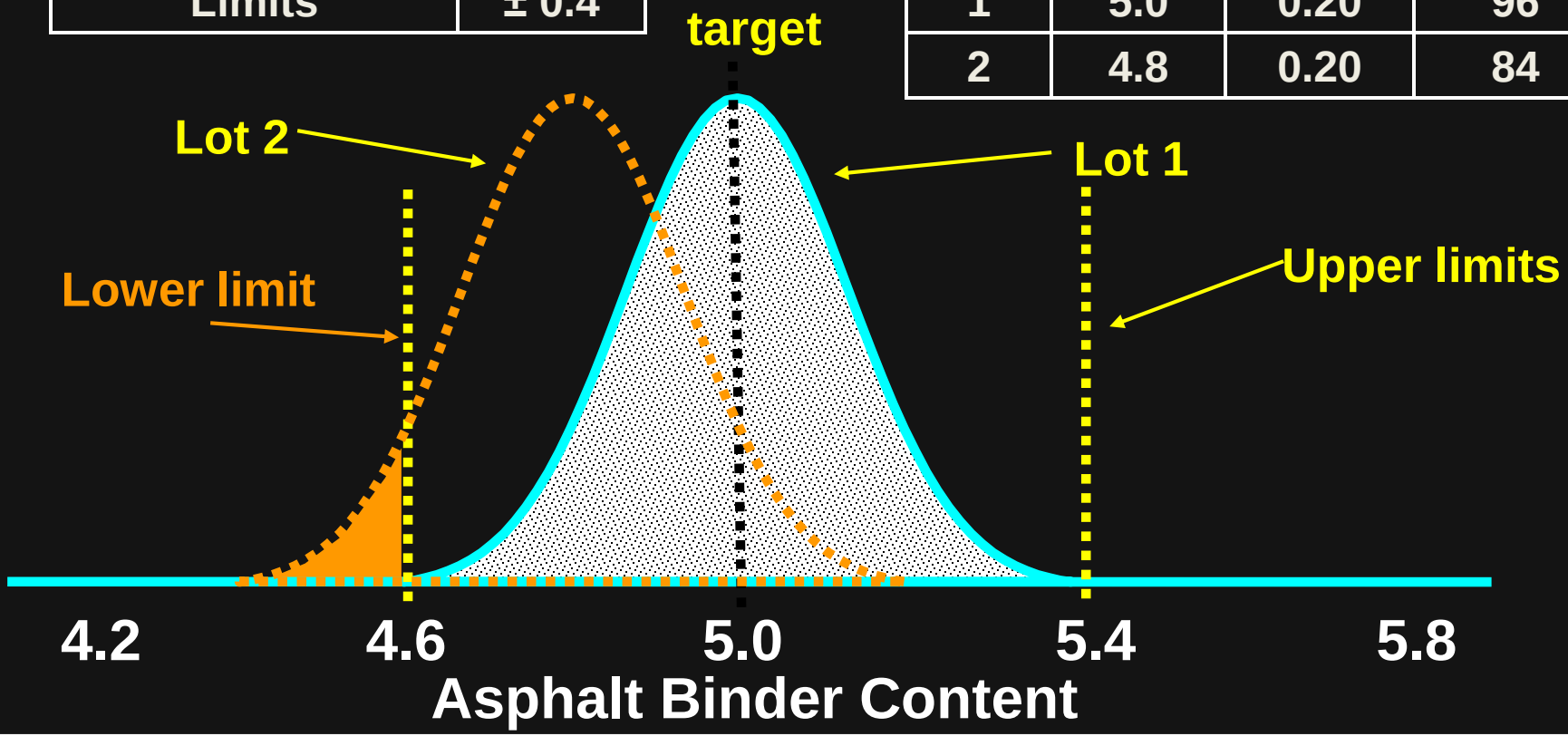
Why Understand Testing Variability

- Provide quality product to our customer
- Remain in business
- Establish specification limits
- Predict pay factors

Percent within Limits

Target Value	5.0
Limits	± 0.4

Lot	X	s	PWL
1	5.0	0.20	96
2	4.8	0.20	84



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Fog Seal

- Asphalt Quality
  - Transverse
  - Longitudinal
- Variability of Surface

Slurry Seal/Micro-Surface

- Mix Design
- Mix Properties (Pre-Construction/Construction)
- Individual Material Properties
- Individual Mixture Quantities
  - Binder
  - Aggregate
  - Additives
- Quantities Placed
  - Transverse
  - Longitudinal

Chip Seal

- Design
- Individual Material Properties
- Quantity Placed (Aggregate/Asphalt)
  - Transverse
  - Longitudinal

Asphalt Mixture

- Mix Design
- Mix Properties
- Individual Material Properties
- Individual Mixture Quantities
- Quantity Placed

Resolution

- Solve Recurring Issues prior to Construction
  - Sample Location
  - Test Variability
  - Reasonableness of Specification
- Pre-Construction Meeting
- Specification – Clear Method for Solving Disputes
- Public Agency/Contractor/Material Supplier Meetings
- Partial Pay
- Performance Warranty
- Arbitration
- Legal

Remember…

- Time is Money
- Remove & Replace – Costly
- Owner Must Be Satisfied


Questions?