



Improving Texas's Roadway Network through Balanced Mix Design of Asphalt Pavements

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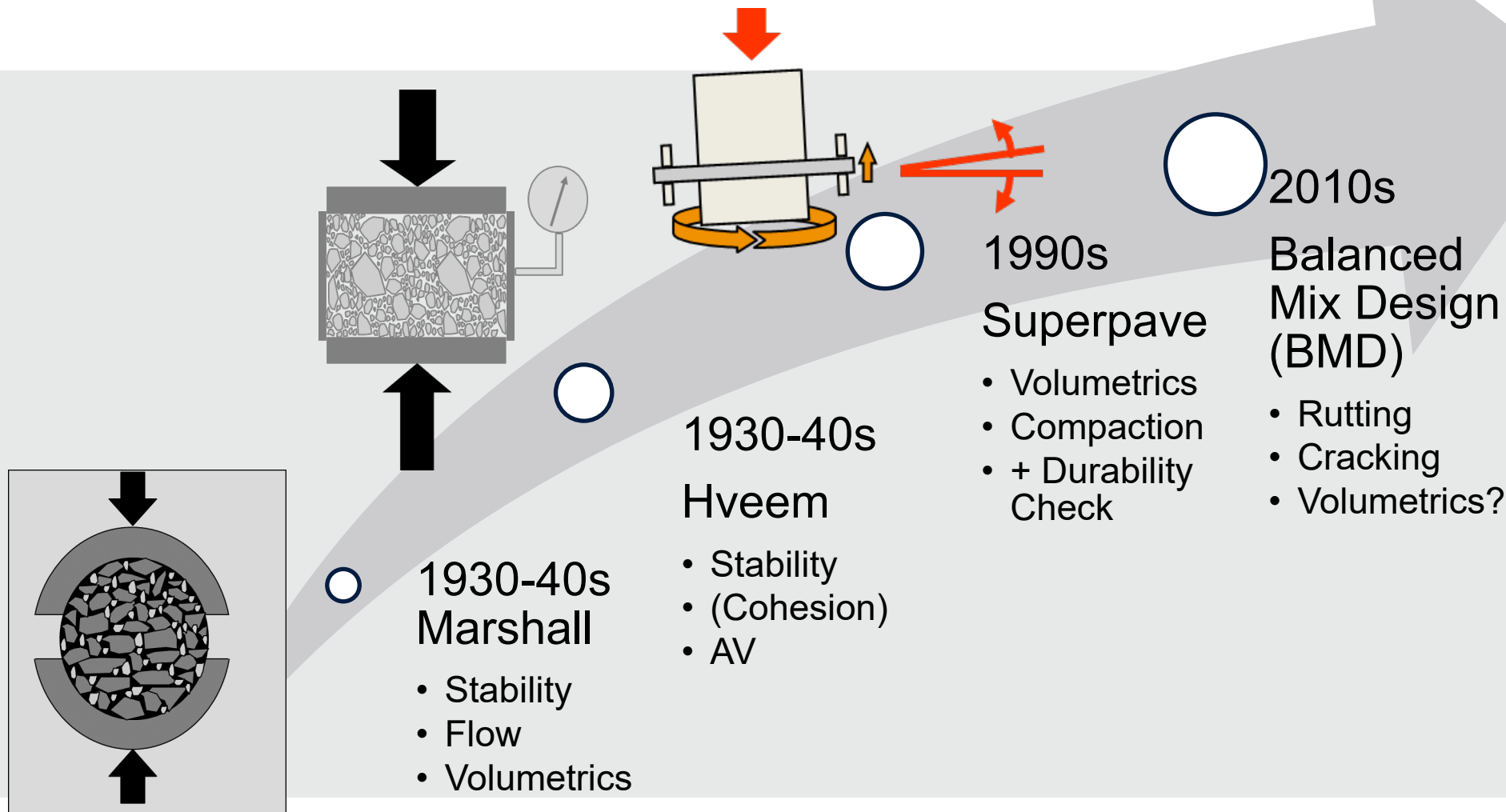
Outline

- **Background of Volumetric Mix Design**
- **Background of Balanced Mix Design**
- **US 67 Project**
 - 32% RAP BMD Design
 - 40% RAP BMD Design
 - Sustainability

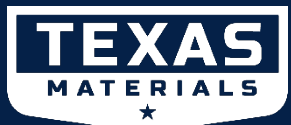


Asphalt Concrete Mix Design

Surface 94% of 2.8M paved miles



Volumetric (Superpave) Mix Design



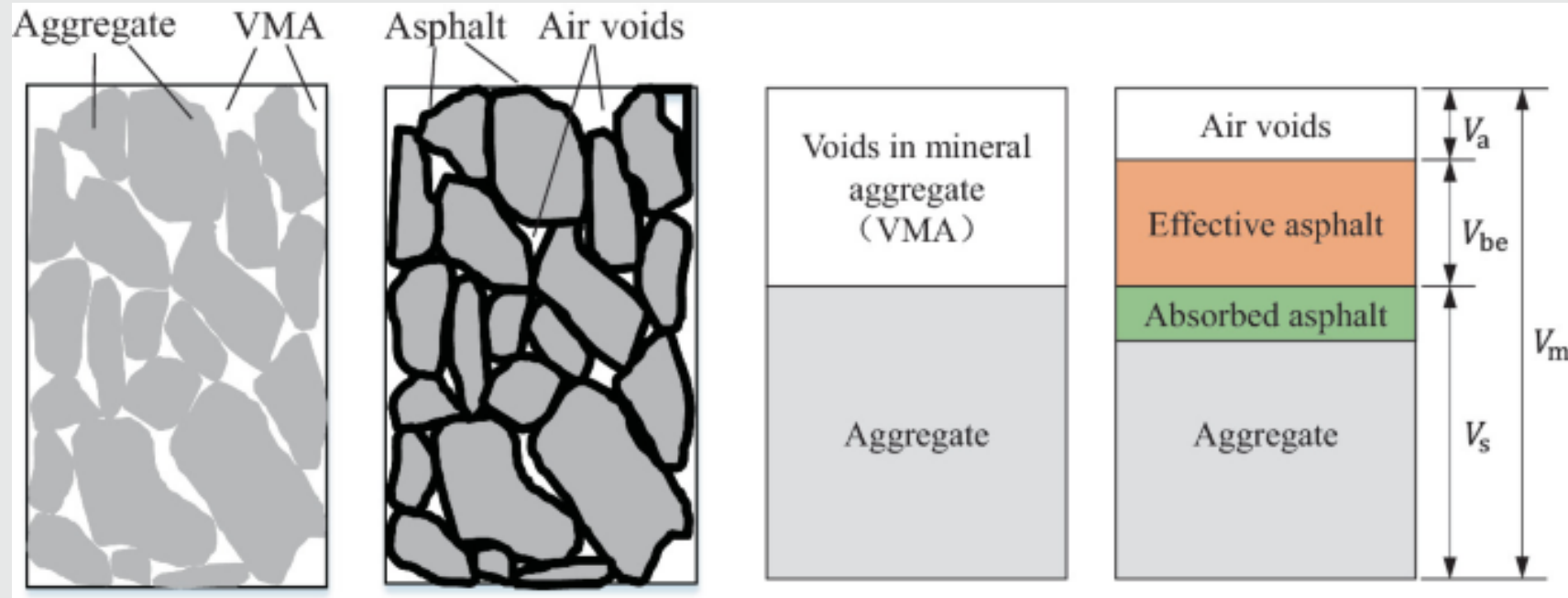
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Asphalt Volumetric Mixture Design

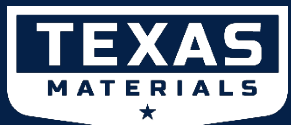
- **Superpave**

- Specifies blended aggregate gradation band, aggregate properties, and binder properties.
- Volumetric Design
 - Design air voids: allows expansion without bleeding and instability but excludes air and moisture
 - Voids in the mineral aggregate: room for effective asphalt and air voids
 - Asphalt content: percent of asphalt by weight of total mix



Only considers Quantity

Balanced Mix Design (BMD)

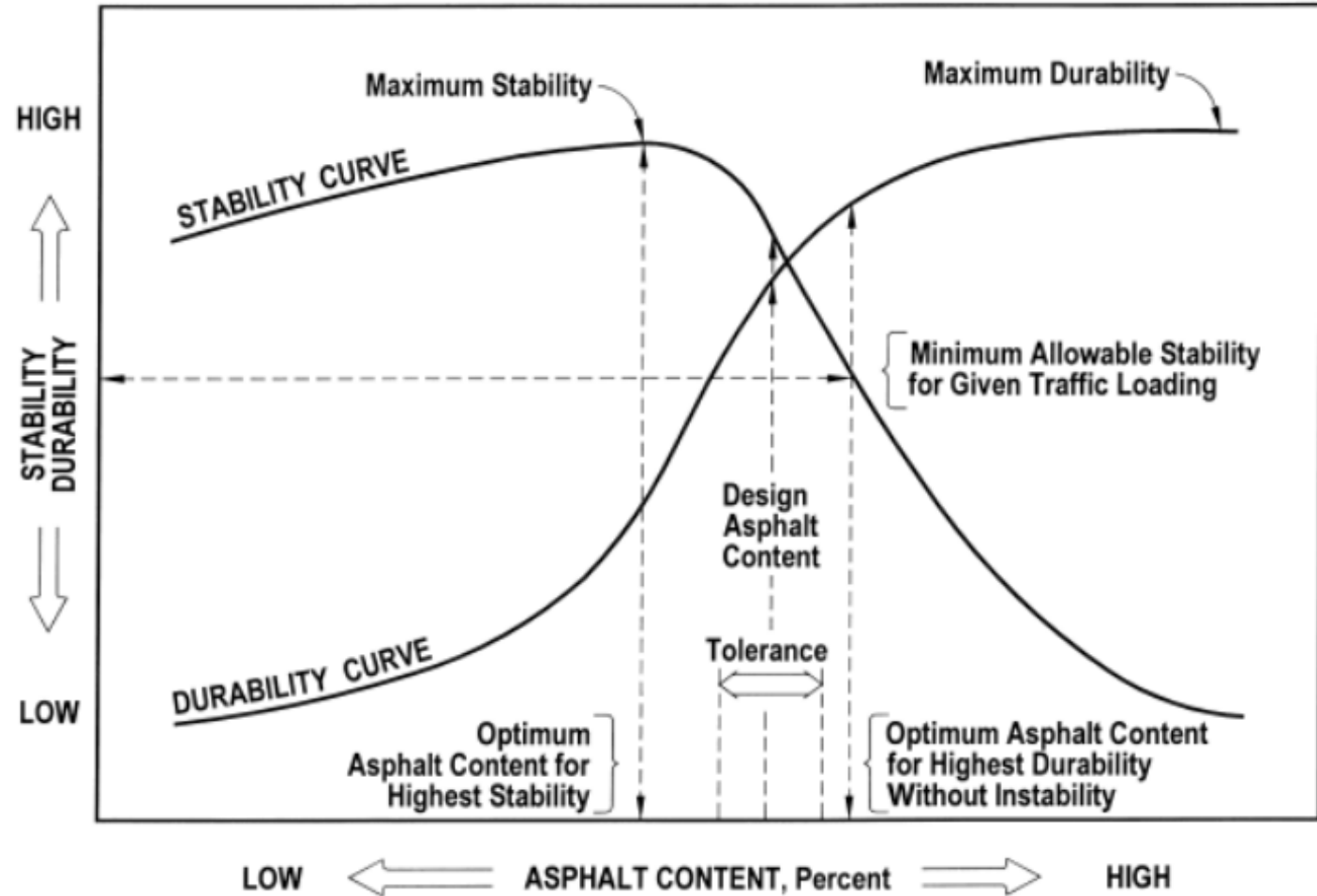


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Balanced Mix Design

- Includes performance testing
- Considers quantity and quality
- Addresses multiple modes of distress
- Typical modes of distress:
 - Cracking
 - Rutting



Source: Federal Aviation Administration, 2013

Figure 3-1. Schematic of stability–durability relationship of hot-mix asphalt, illustrating philosophy of selecting design asphalt content.

Most Common Pavement Distresses



Cracking

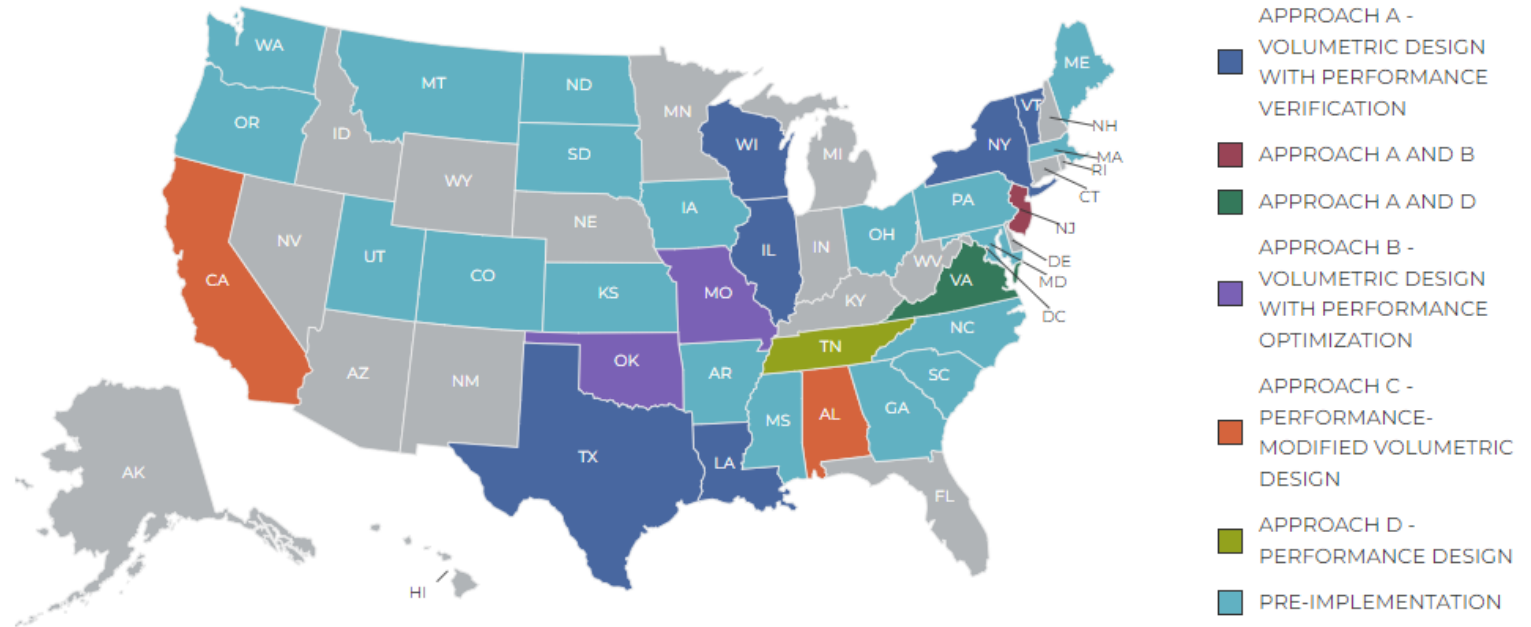


Rutting

Texas Balanced Mix Design

BMD concept was reintroduced by Texas A&M Transportation Institute (TTI).

- **Hamburg Wheel Test**
- **Overlay Test**
- **Optimum binder content and grade determined by performance test results**



Cracking Tests

Overlay Test (OT)



Crack Progression Rate (CPR)

$$\downarrow \text{CPR} = \uparrow \text{Cracking resistance}$$

Indirect Tensile Asphalt Cracking test (IDEAL-CT)

$$\uparrow \text{CT}_{\text{index}} = \uparrow \text{Cracking resistance}$$



Rutting Test

Hamburg Wheel Test (HWT)



↓ Rut Depth = ↑ Rutting resistance



3074 Balanced Mix Design

Hamburg Wheel Test (HWT) (Tex-242-F)

3074 Table 11A

High-Temperature Binder Grade	Minimum # of Passes at 12.5mm Rut Depth, Tested at 50°C
PG 64 or lower	10,000
PG 70	15,000
PG 76 or higher	20,000

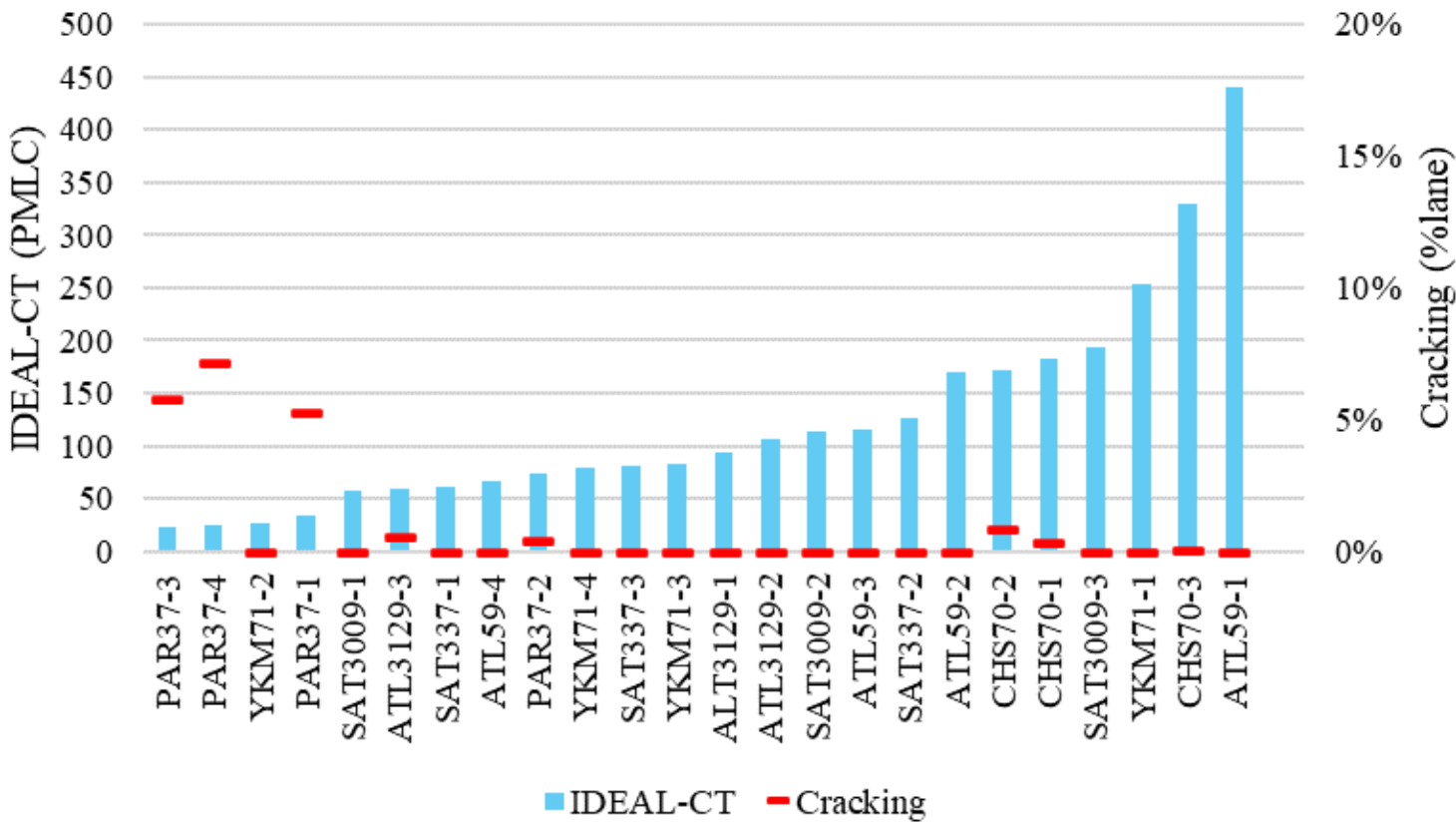
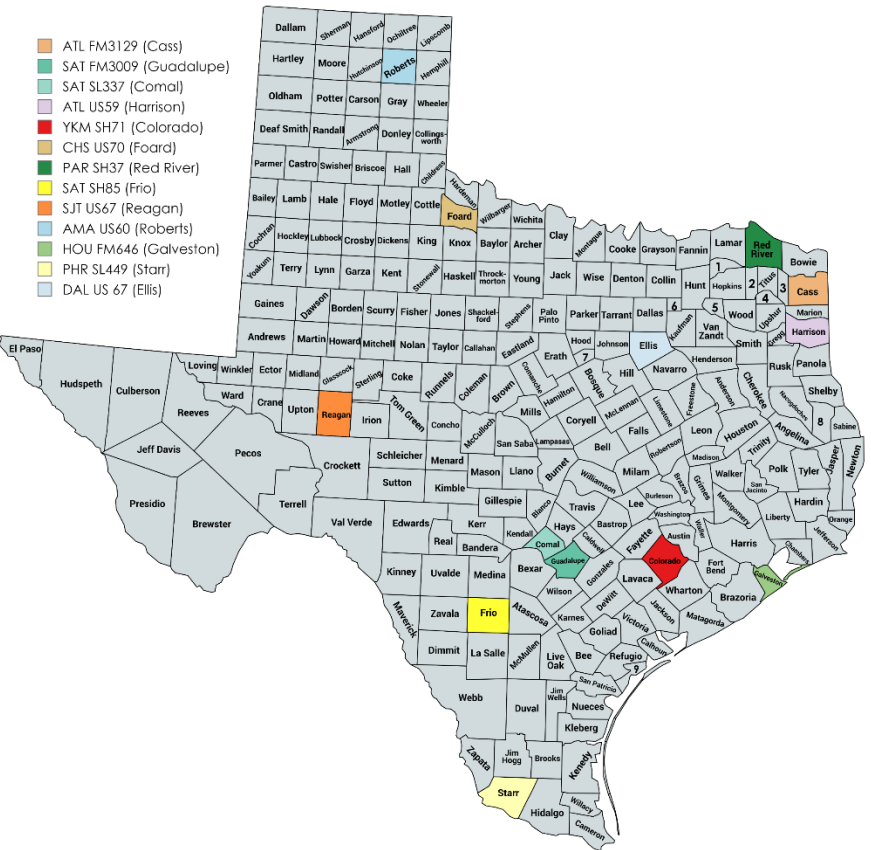
Overlay Test (OT) (Tex-248-F)

3074 Table 11B

Mixture Property	Surface Mixture
Critical Fracture Energy (CFE), in.-lb/in.2, Min.	1.0
Crack Progression Rate (CPR), Max.	0.45

***Can monitor cracking performance through correlations between the OT and the IDEAL Cracking Test (IDEAL-CT) following JMF1 approval**

Field Cracking IDEAL-CT Validation



US 67 Project

Largest BMD Project in TX

First Large Scale 40% RAP
Surface Mixture in TX



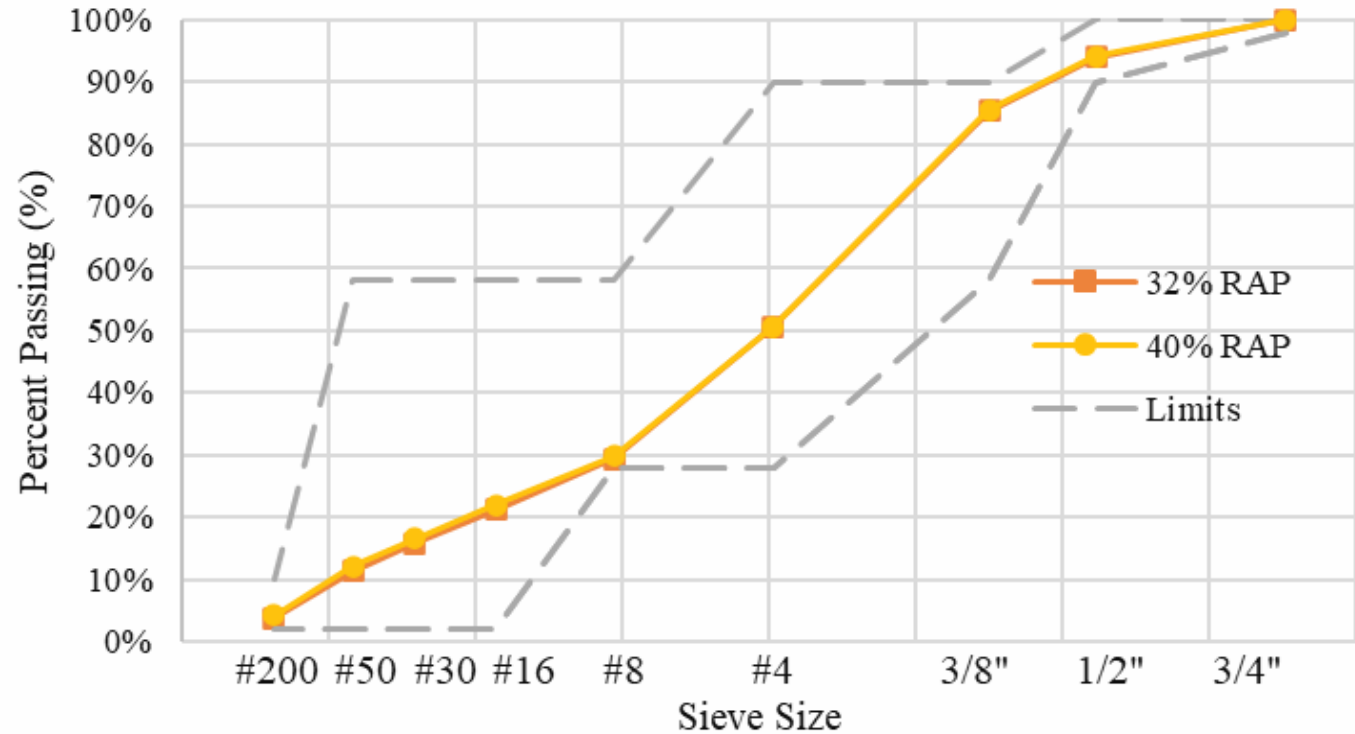
US 67 Project Location

Through The City of Midlothian, TX



Mix Design

Design Parameter	32% RAP Design	40% RAP Design
Reclaimed Asphalt Pavement, RAP (%)	32	40
Recycle Binder Ratio, RBR (%)	28.4	36.4
Performance Grade (PG)	70-22	70-22
Total Asphalt Content, AC (%)	5.6	5.5
Virgin Asphalt Content, AC (%)	4.0	3.5
Gyrations	35	35
Target Density (%)	96	97



Construction

Constructed at night for traffic considerations.

Paved using normal equipment, tolerances, and procedures.

Testing using traditional and BMD tests.





TEXAS DEPARTMENT OF
TRANSPORTATION
Plot Control Chart - 2014 QC/QA
Template

TXCC14 - File Version :: 07-28-2016

SAMPLE ID:		SAMPLED DATE:	
LOT NUMBER:	17	LETTING DATE:	
SAMPLE STATUS:		CONTROLLING CSJ:	
COUNTY:	Ellis	SPEC YEAR:	2014
SAMPLED BY:		SPEC ITEM:	
SAMPLE LOCATION:	Alvarado	SPECIAL PROVISION:	
MATERIAL CODE:	6073	MIX TYPE:	SS-3074-BMD-SP-C
MATERIAL NAME:	3074 BMD SP-C 70-22-R		
PRODUCER:	Texas Materials		
AREA ENGINEER:		PROJECT MANAGER:	
COURSE/LIFT:	Surface	STATION:	
		DIST. FROM CL:	

Import

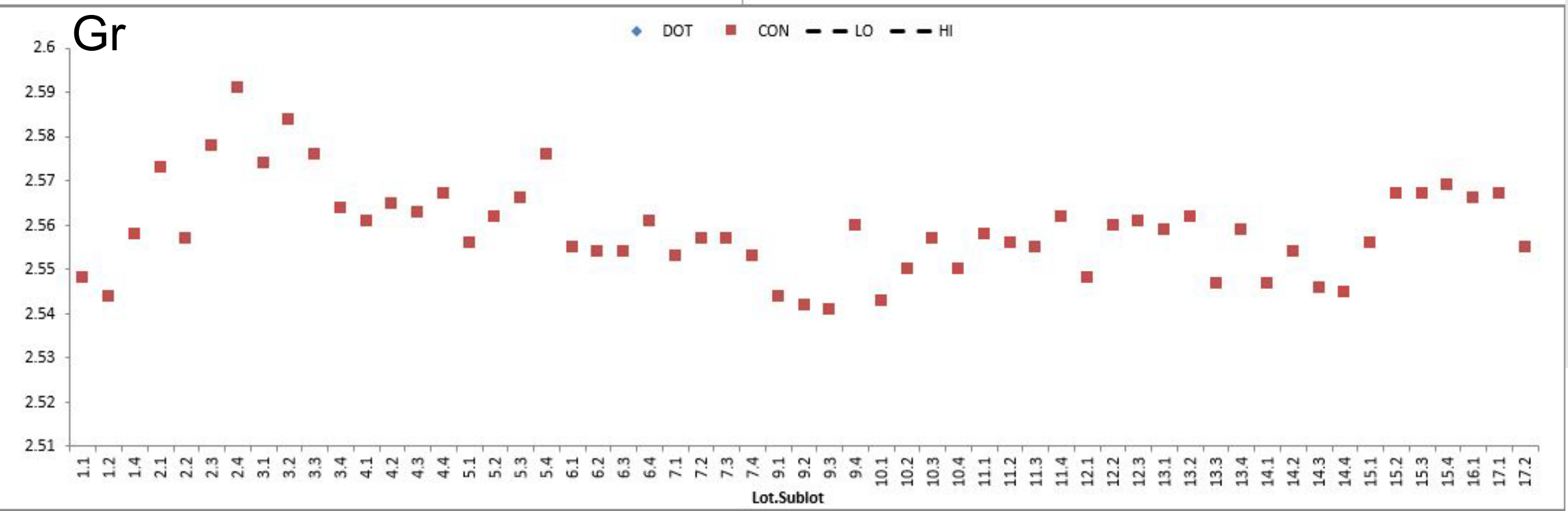
Update

Clear

Select a lot:
Lot17

Delete Lot

Plot what:
Rice





TEXAS DEPARTMENT OF
TRANSPORTATION
Plot Control Chart - 2014 QC/QA
Template

TXCC14 - File Version :: 07-28-2016

SAMPLE ID:		SAMPLED DATE:	
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Import

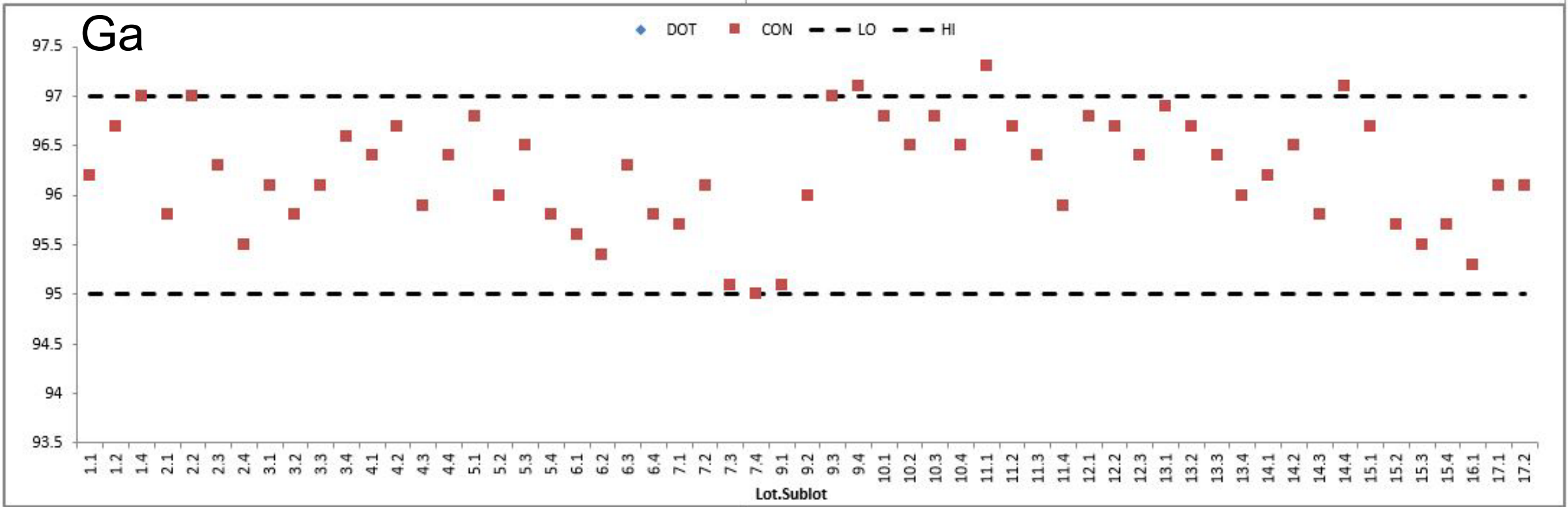
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Clear

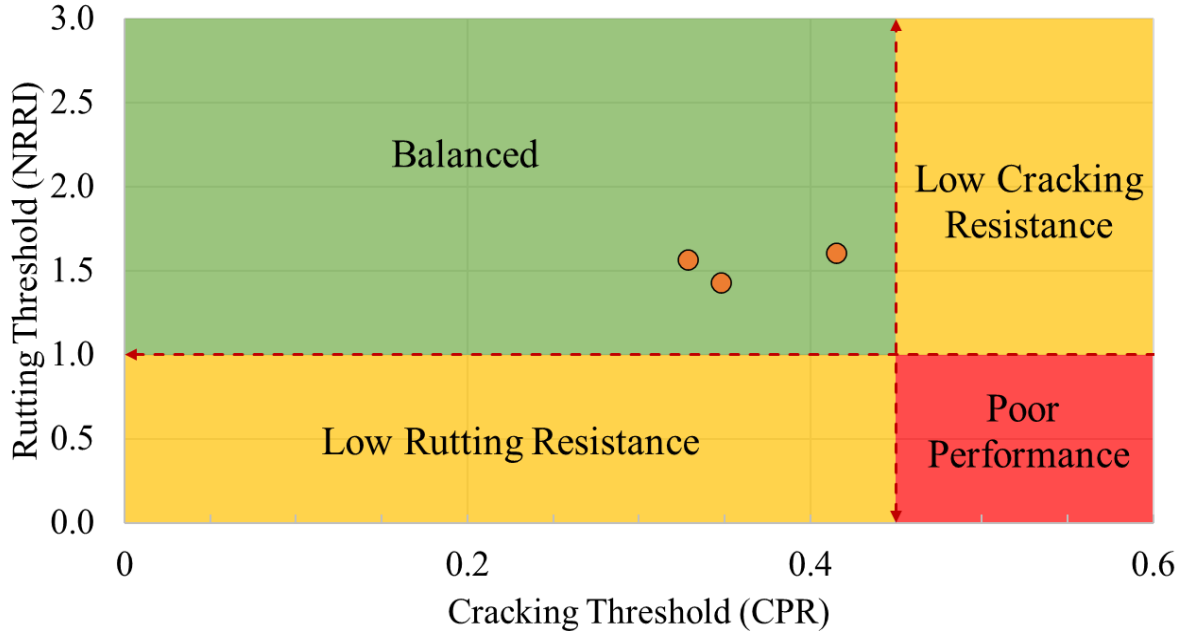
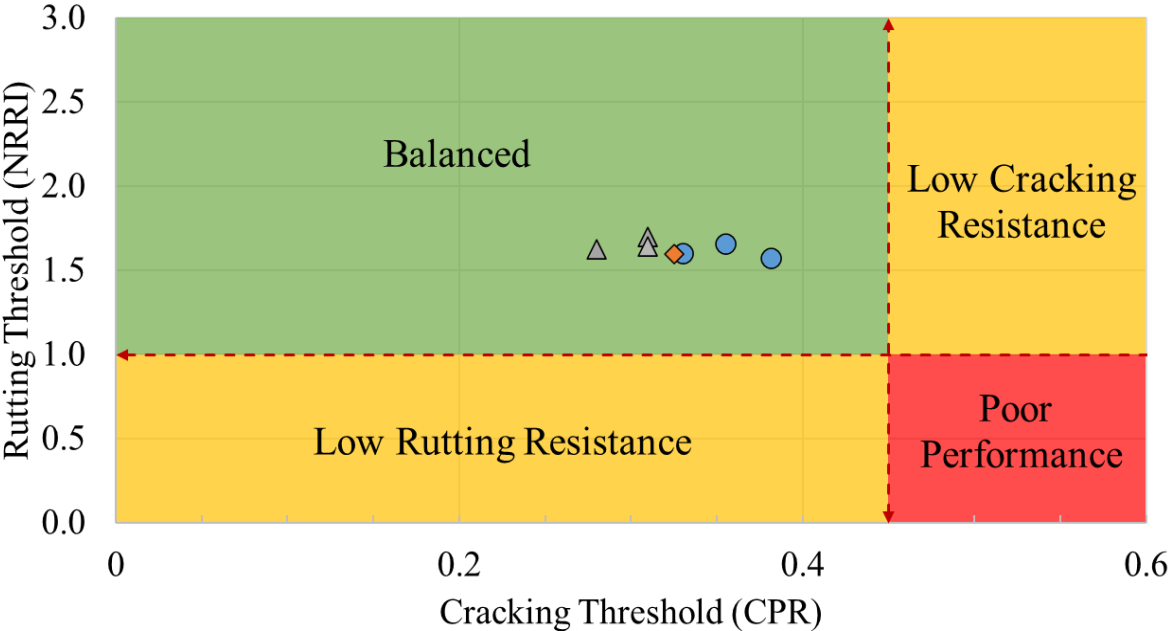
Select a lot:
Lot17

Delete Lot

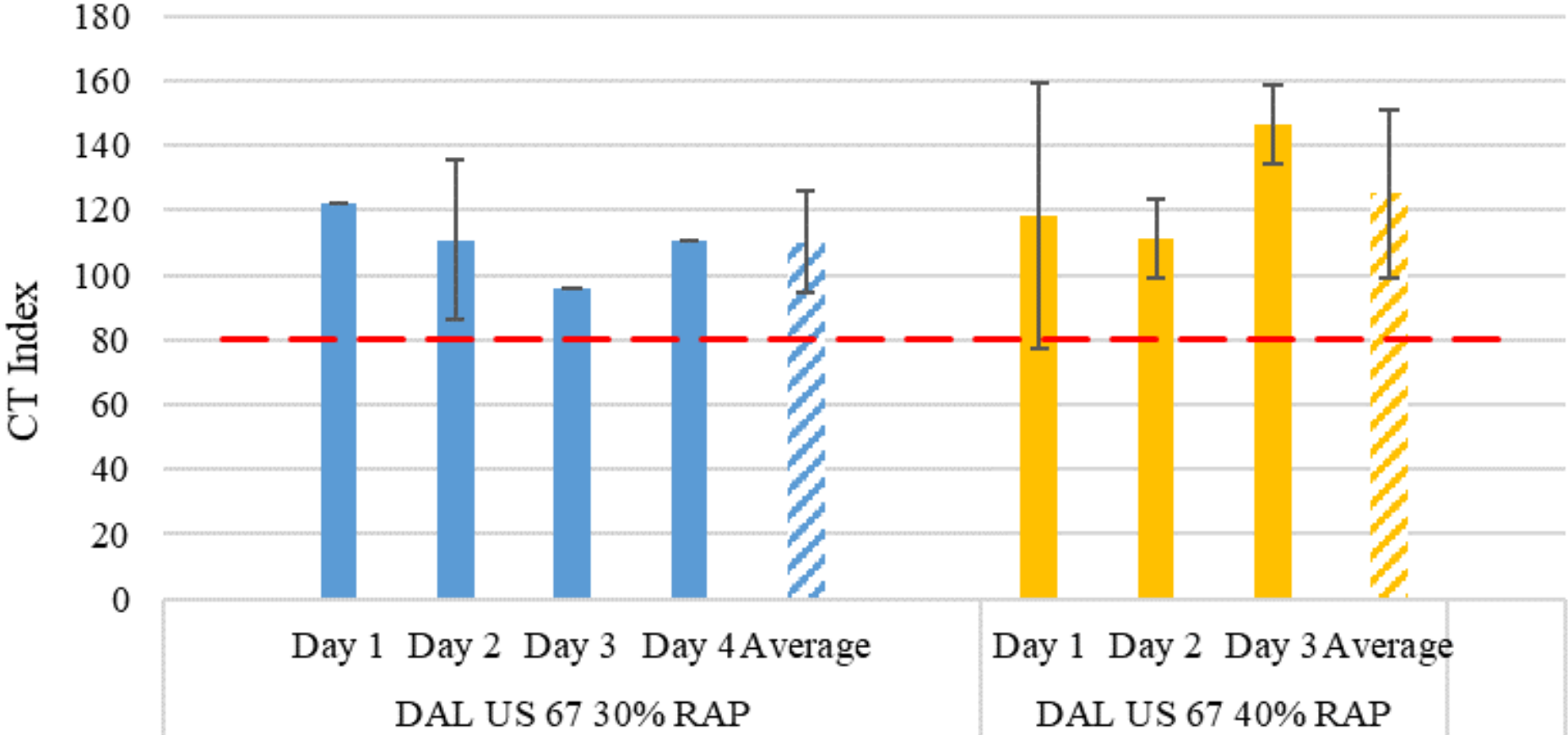
Plot what:
Density



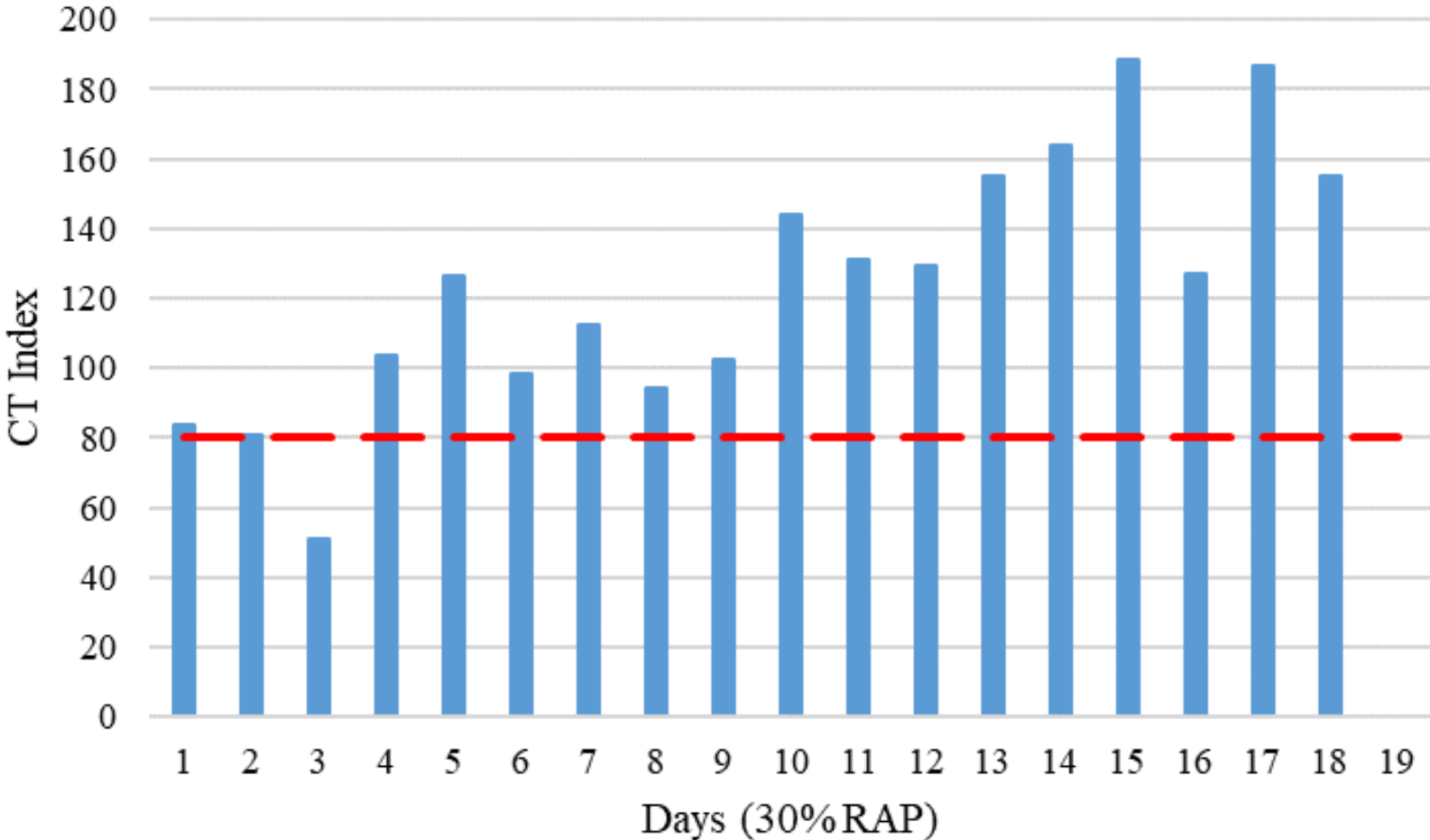
Balancing Cracking and Rutting Resistance



Production Performance: TTI Data



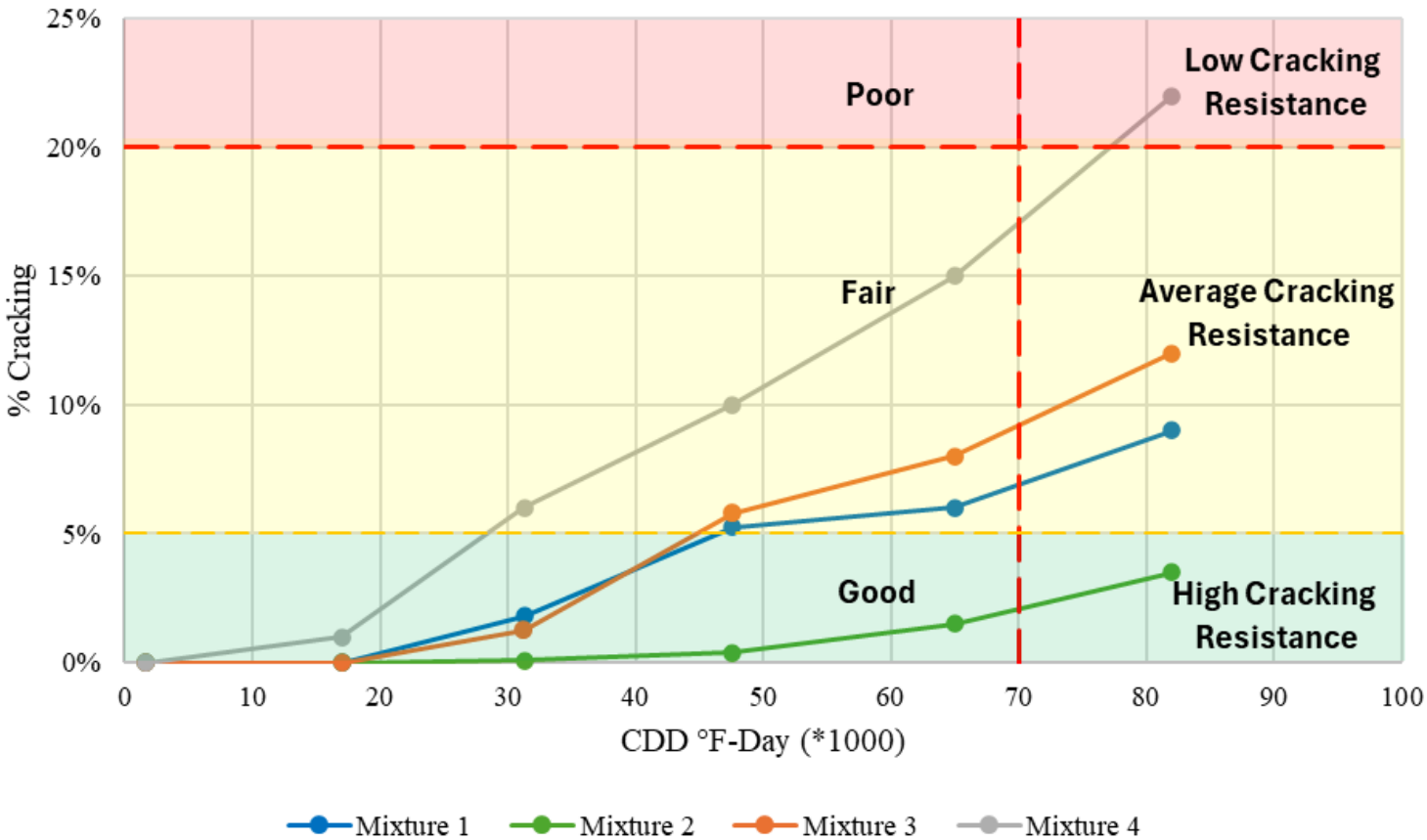
Production Performance: Contractor Data



Monitoring of DAL US 67



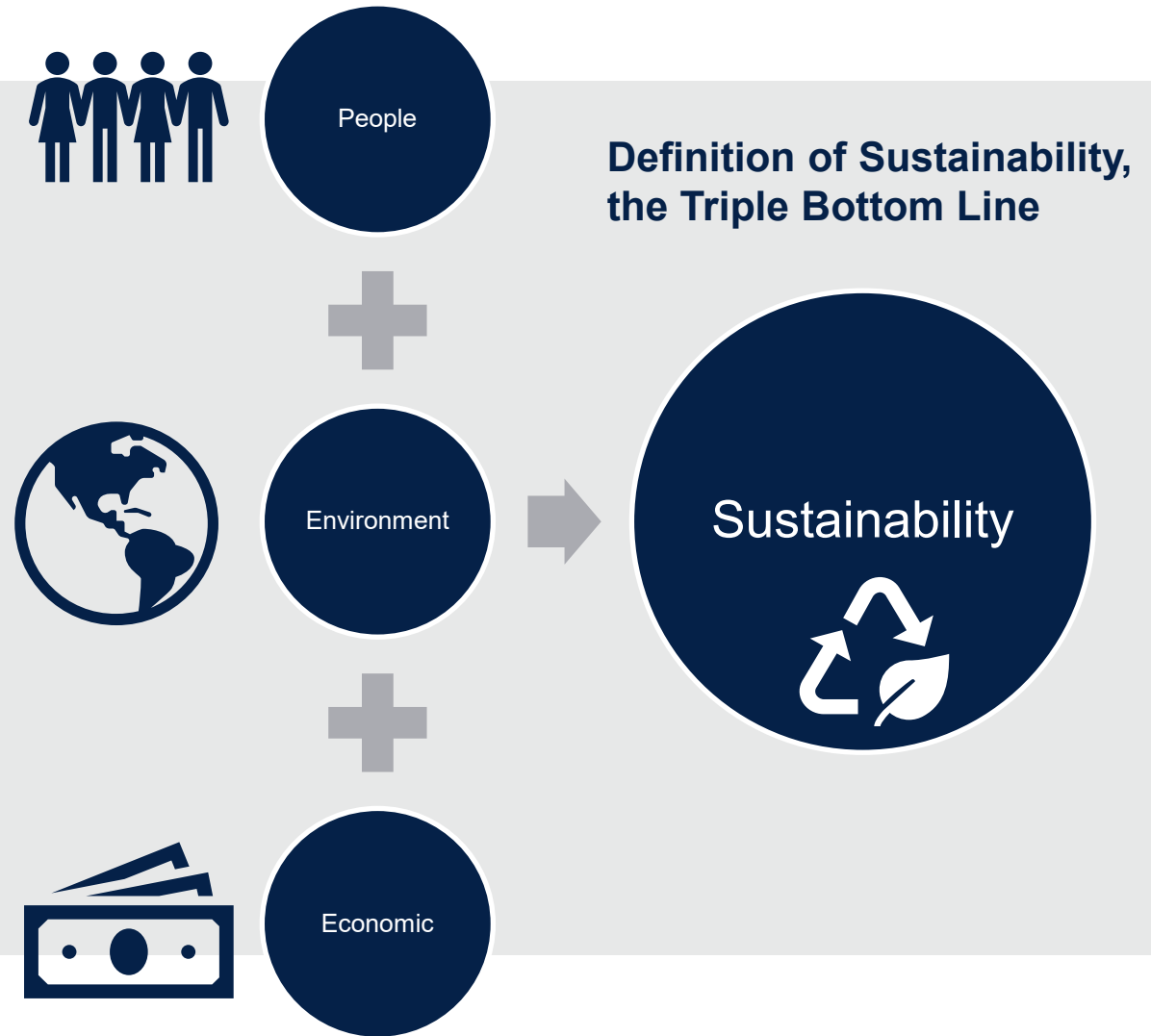
- Cracking, Rutting, and other distresses will be monitored each year.
- Correlations will be drawn between Field performance and laboratory tests.



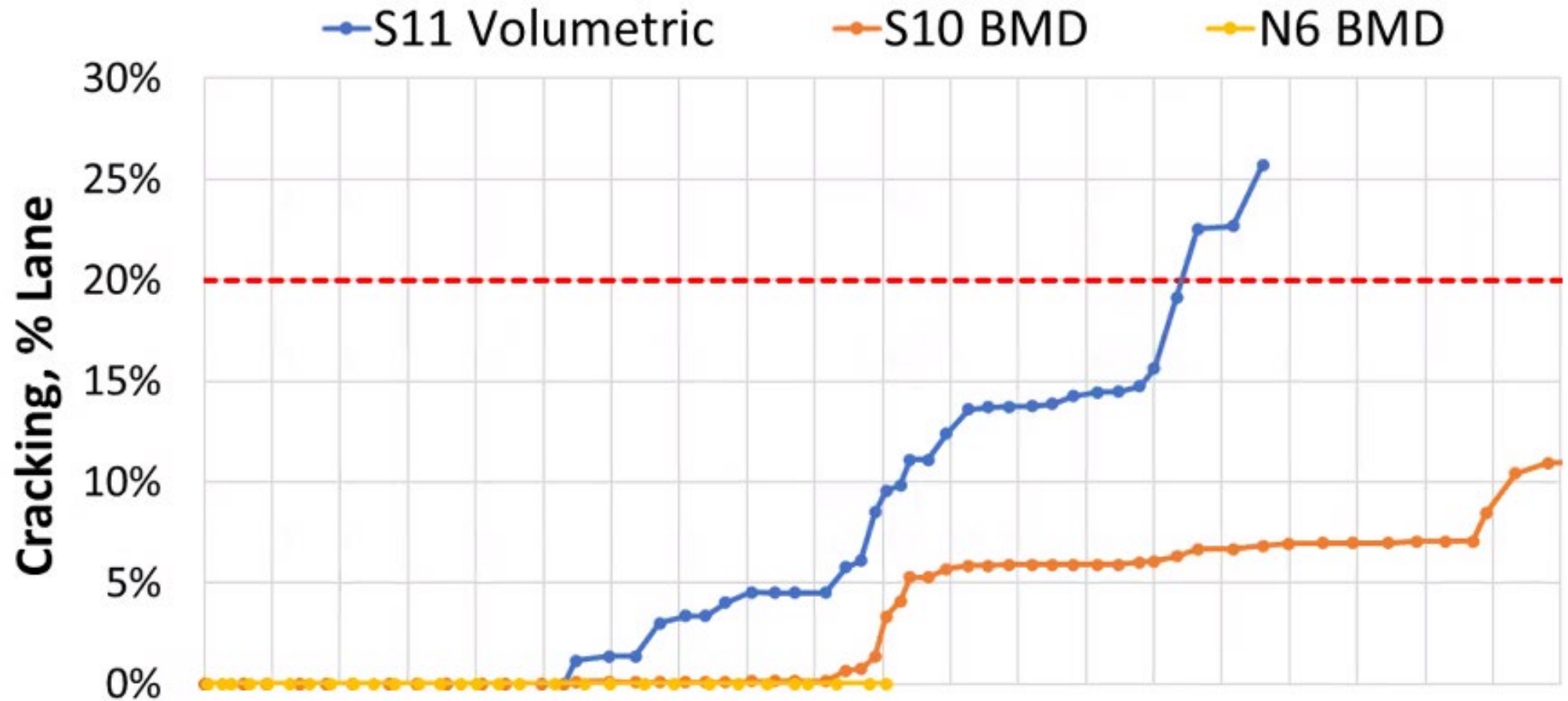
Sustainability

- **Studies have shown:**

- Laboratory performance correlated to field performance.
- BMD test sections have performed longer than the Superpave control test section.
- BMD could last longer which could stretch taxpayer dollars and reduce disruptions to the traveling public and local businesses.



NCAT Test Track: Texas BMD Verification



Sustainability

EPD's Global Warming Potential

kg CO2 Equiv./ton

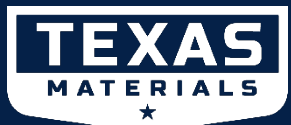
SP-C	32% RAP	40% RAP
53.27	53.23	49.75



Virgin Material Savings

Design	(Ex. SP-C)	32% RAP	40% RAP	Total US 67 Savings
Total Tons of Mix	(47,774)	36,464	11,310	47,774
Tons of Aggregate	(6321)	11,015	4307	15,322
Tons of Asphalt	(334)	580	227	807
Virgin Aggregate Savings Compared to SP-C	-	9,002 tons 1,286 truck loads		
Virgin Asphalt Savings Compared to SP-C	-	473 tons 43 tanker loads		

Thank you!
Questions?



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Contacts for Questions



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