DEVELOPMENT OF RUBBER BINDER SPECIFICATIONS IN CALIFORNIA: PROJECT UPDATE

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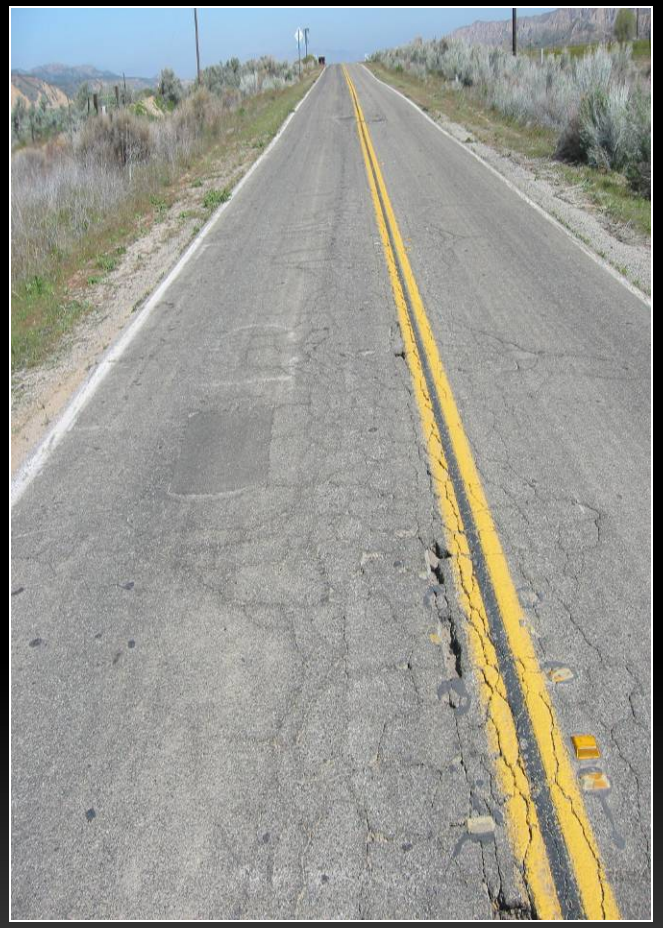
Summary

- AR Research Update
- AR Specs Overview
- DSR Geometry Key Findings
- Short Term Oven Aging
- Work in Progress
- Conclusions



AR Research Update

- Asphalt rubber binder specifications
  - Phase 1 report complete, Phase 2 in progress
- PG+5
- Superpave mix design for R-HMA
  - Report with Caltrans
- Rubberized RAP in conventional HMA
  - Testing in progress
- RAP/RAS in rubberized mixes
  - Testing in progress
- In-place recycling of R-HMA
  - Phase 1 (dry testing) report compete and posted
  - Phase 2 (wet testing) in progress

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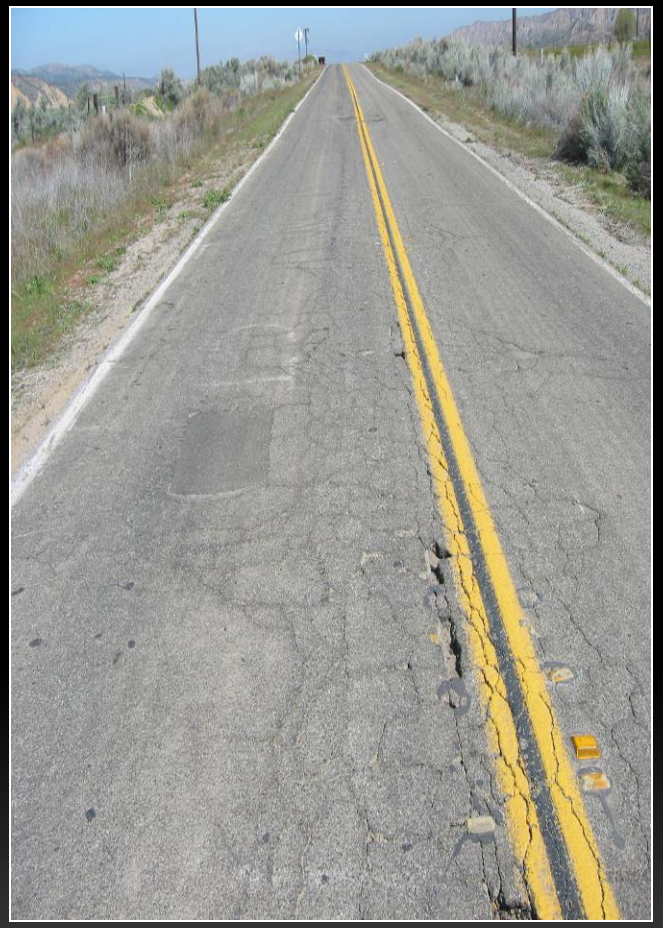

AR Binder Specs Ph1 Overview

- Wet process produced at asphalt plant
  - Used in gap- and open-graded mixes
  - Terminal blend covered under Caltrans PG-M specification
- Review of Caltrans specifications
  - 20 ±2% crumb rubber modifier (CRM)
  - 100% passing #8 (2.36mm)
  - 25 ±2% high natural rubber
  - Ambient ground
  - Extender oil permitted (Type II, 2 to 6% x wt. of binder)
  - QC is viscosity and penetration
- Objective
  - Develop a PG type spec for wet process AR binders

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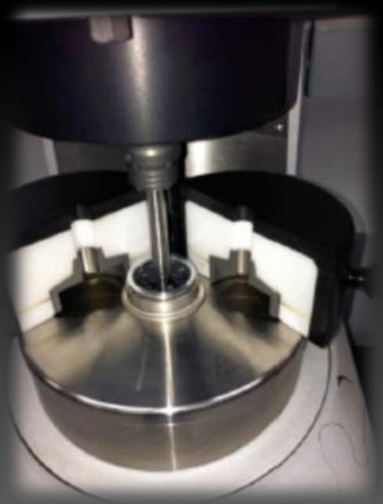
Background

- Superpave binder spec not developed for binders with particulates
  - DSR parallel plate geometry not considered appropriate – requires gap size of 8mm to comply with test physics
    - Tests rheology of rubber particles, not binder
  - RTFO aging is difficult for binders with particulates
- Caltrans specs/QC testing therefore limited to viscosity and penetration
  - Not good indicators of performance
- Phase 1 study
  - Identify most appropriate test procedures to obtain realistic PG grading

Background

- DSR
  - Concentric cylinder with 7mm gap considered more appropriate than parallel plate
- BBR
  - Specimen preparation
- Short and long-term aging
  - Temperature and quantity adjusted to represent AR



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Procedure

- Compare DSR geometries on conventional, polymer-modified (PM), and terminal blend (TR) binders
- Compare DSR geometries for testing asphalt rubber binder containing crumb rubber particles of various sizes
- Evaluate the effects of different crumb rubber particle sizes on high, intermediate, and low temperature properties

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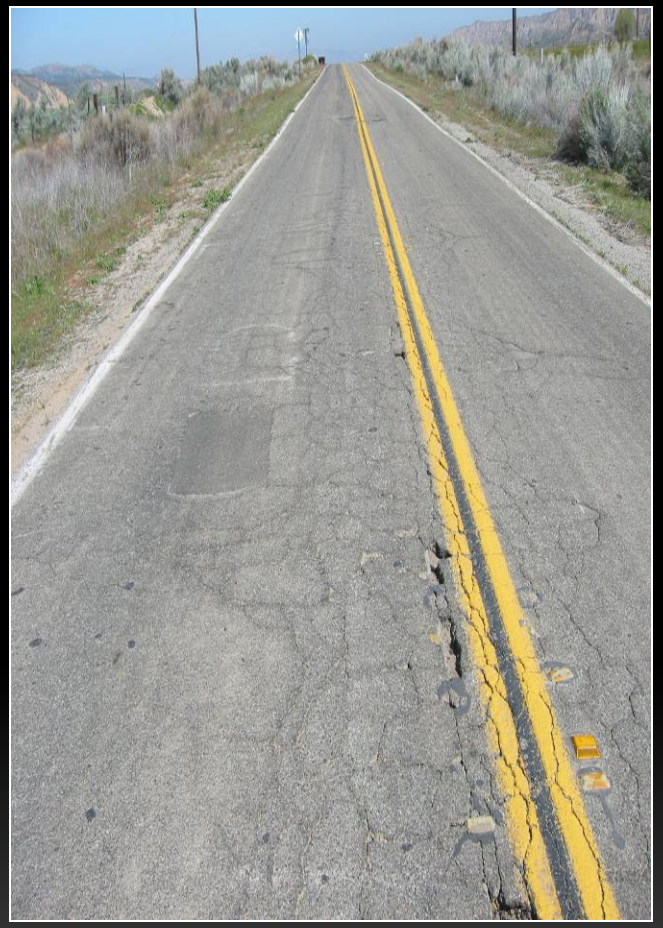

DSR Geometry Key Findings

- Multiple size ranges tested, with focus on:
  - 180-250µm, 250-425µm, 425-850µm, >850µm
  - (80-60#, 60-40#, 40-20#, >20#)

Particle Size Range		Correlation Between Geometries (R^2)		
µm	#mesh	G* (kPa)	δ (°)	G*/sin(δ) (kPa)
180-250	60-80	0.9973	0.9834	0.9963
250-425	40-60	0.9467	0.9621	0.9497
425-850	20-40	0.9504	0.9020	0.9490
Combined		0.9500	0.9294	0.9508

- Poor correlations with particle sizes >850µm
  - Less than 50% actual size used in California

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DSR Geometry Key Findings

- Poorer correlations with increasing CRM size
  - Cut-off appears to be at 250µm
- True PG
  - CC gives higher true PG than PP
- Percent recovery @ 64°C and 3.2 kPa
  - CC gives higher % recovery than PP
- J_{nr} @ 64°C and 3.2 kPa
  - CC gives lower J_{nr} than PP
- Which number is right?

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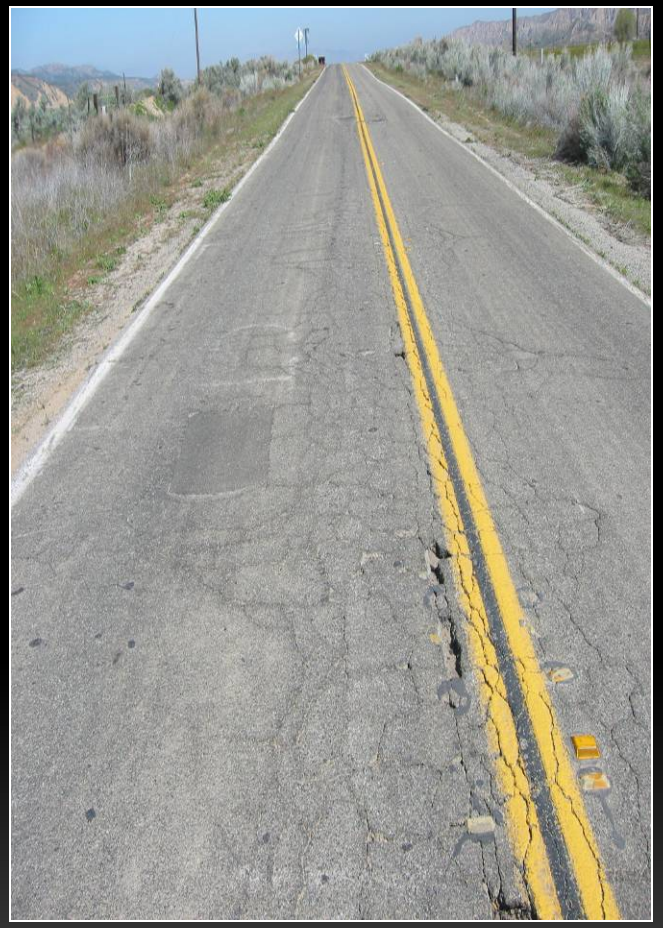

Short-Term Oven Aging

- Phase 1 compared RTFO and TFO
  - Problems with coating, spillage, and retrieval of aged sample
- AASHTO T240
  - Testing temperature: 163°C
  - Binder content: 35g per glass
- Proposed modifications
  - Test temperature: 190°C (Caltrans spec = 190 to 200°C)
  - Binder content: adjusted for rubber content
    - Eg. 20% CRM = 45g per glass = 35g of base binder
  - No tilting of oven

Modified RTFO Procedure

- Early testing indicates satisfactory results
  - Easier initial coating of the bottle
  - Satisfactory bottle coating
  - No spillage observed
  - Easier retrieval of aged binder
  - More binder to work with
- But
  - Increased safety risk at higher temperatures
  - Increased fumes in the binder lab

Modified RTFO Procedure

Aging Temp: 163°C

Aging Temp: 190°C

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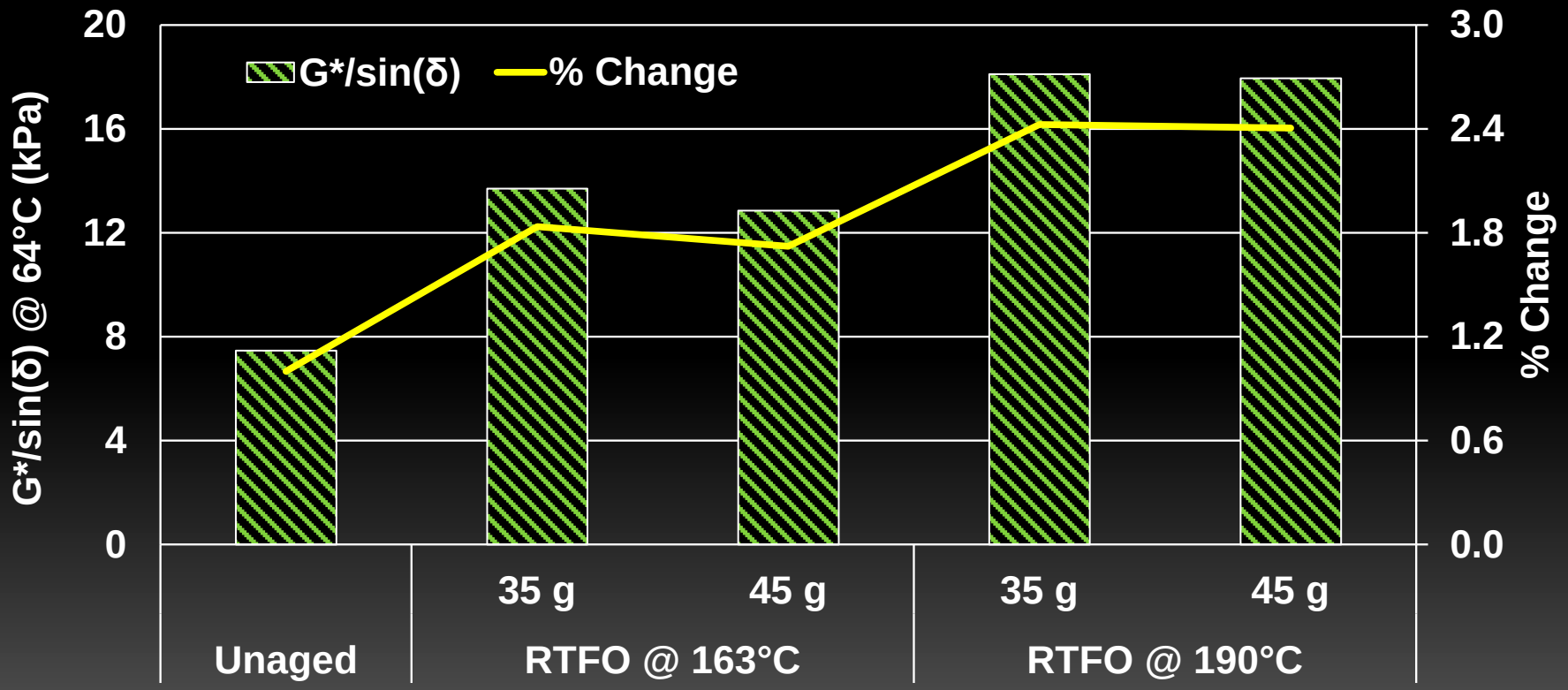
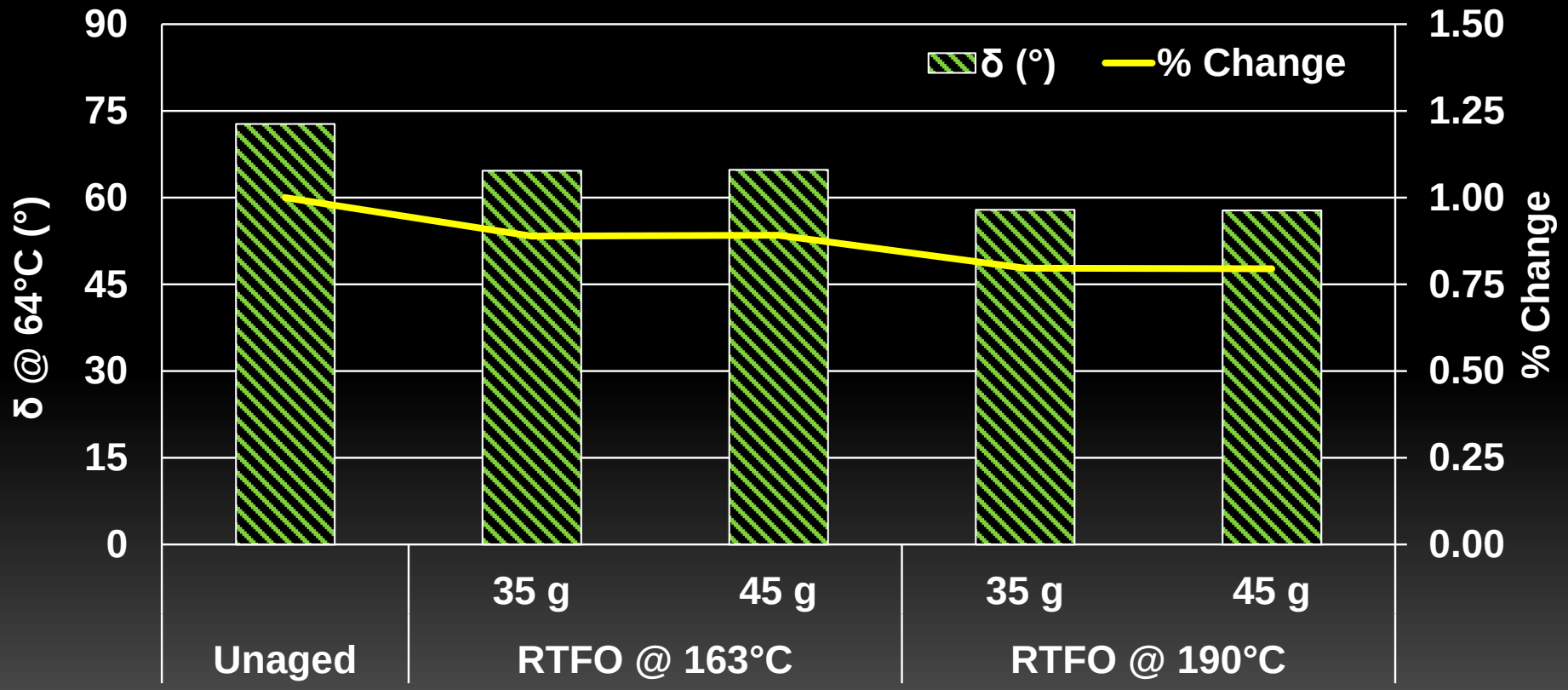
Modified RTFO Procedure

- Initial results
  - Higher G*/sin(δ) at 64°C
  - Quantity did not effect result at higher temperature



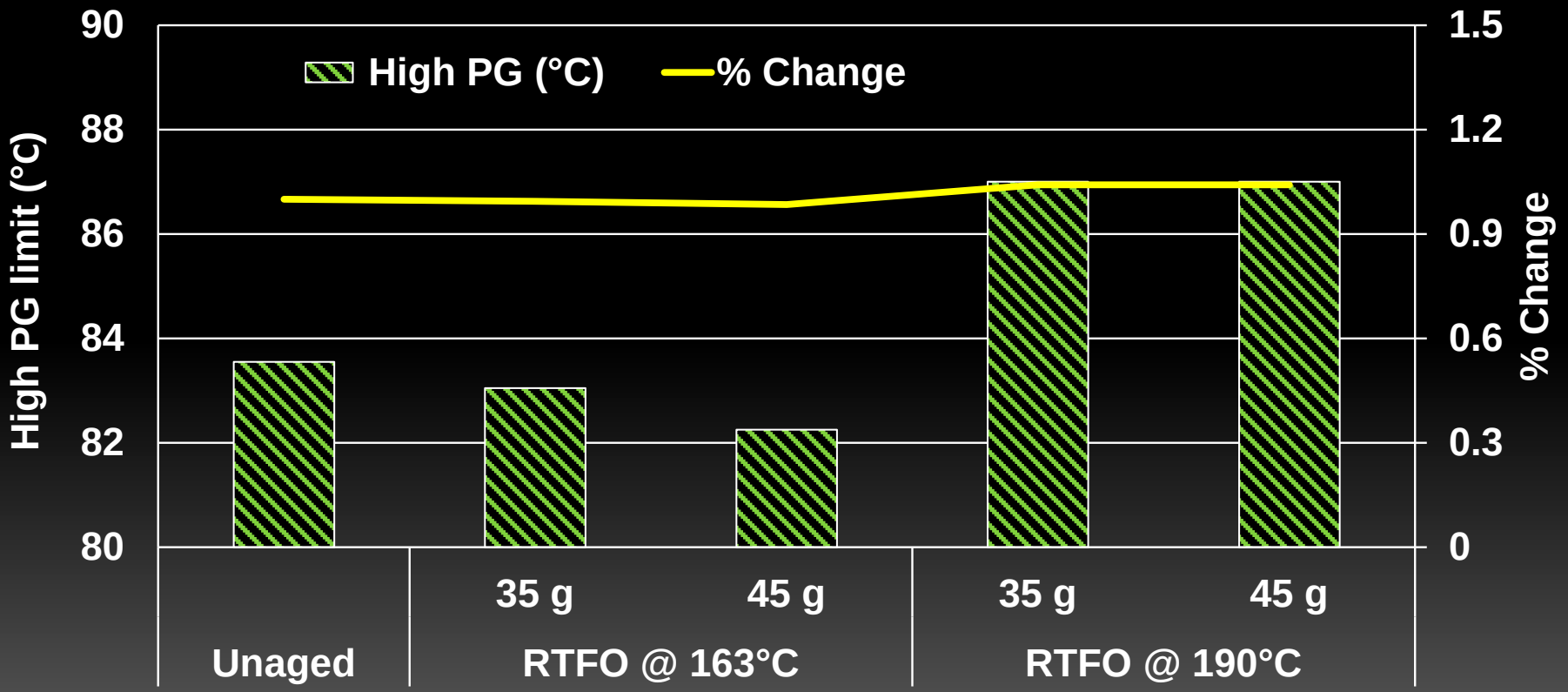
Modified RTFO Procedure

- Initial results
  - Lower phase angle (δ) at 64°C
  - Quantity did not effect result



Modified RTFO Procedure

- Initial results
  - Higher true PG at 64°C
  - Quantity did not effect result



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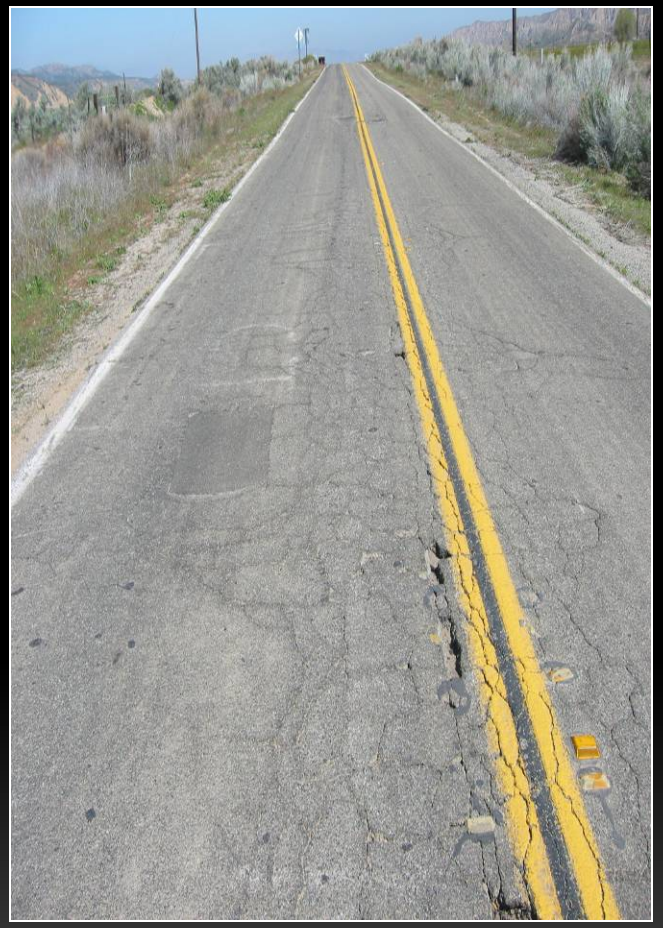

Work in Progress

- Continued comparison of PP and CC geometries.
- Intermediate temperature grading
  - Too stiff for CC geometry with 7-mm gap
  - Investigating 10-mm gap or "binder bar"
- Low temperature grading
  - Refined BBR sample preparation and testing procedure
- Validation
  - Field produced binders and mix performance
- Preliminary PG specification language
  - Validation on Caltrans projects
  - Revised specification language if required

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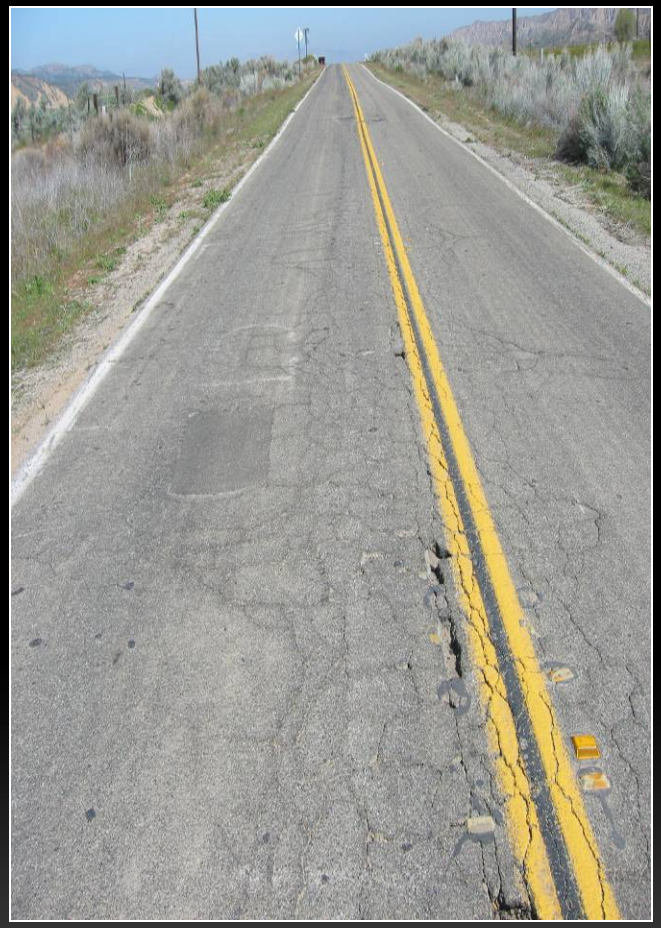
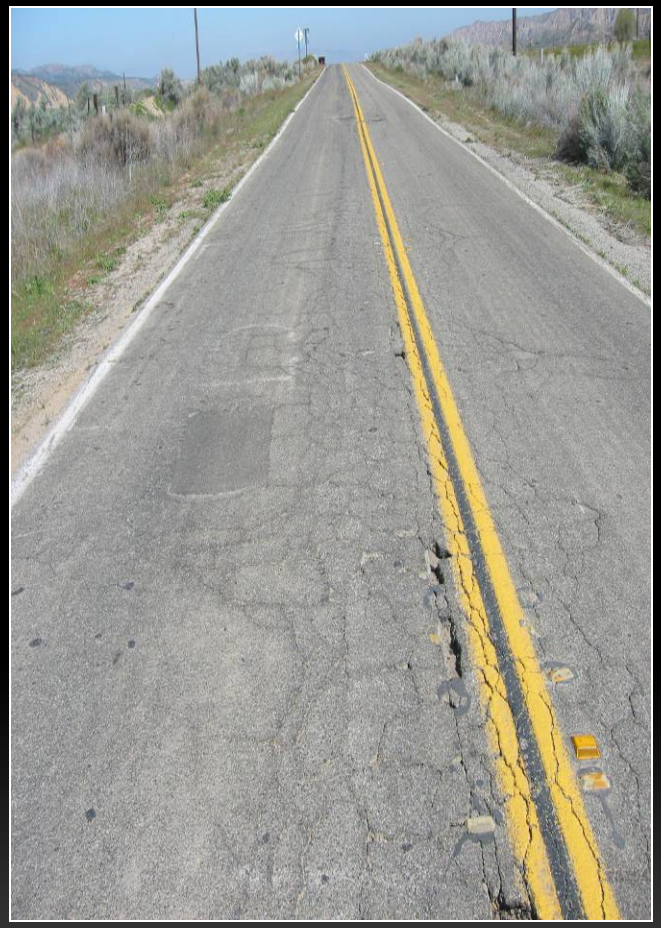


Conclusions

- Based on the results obtained to date:
  - Concentric cylinder geometry is considered to be a potentially appropriate alternative geometry to parallel plates for assessing AR binders containing crumb rubber particles larger than 250 µm.
  - Modified RTFO procedure more representative of field conditions is recommended.
  - Intermediate and low temperature properties in progress.



Thank-you