Implementation of Performance Graded Binder Testing using DSR

Working Group on PG Specs, of RPF Binder Spec Committee

RPF in Cape Town

13th May 2015

Stellenbosch

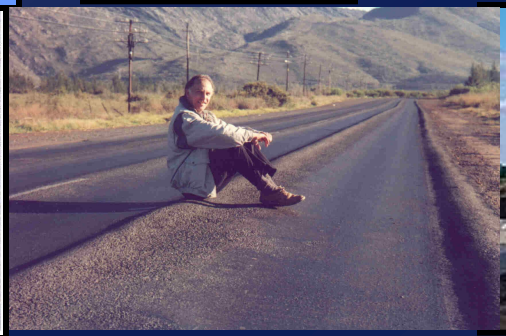
THE SOUTH AFRICAN NATIONAL ROADS AGENCY SOC LTD

Reg. No.1998/009584/06

Performance Grading

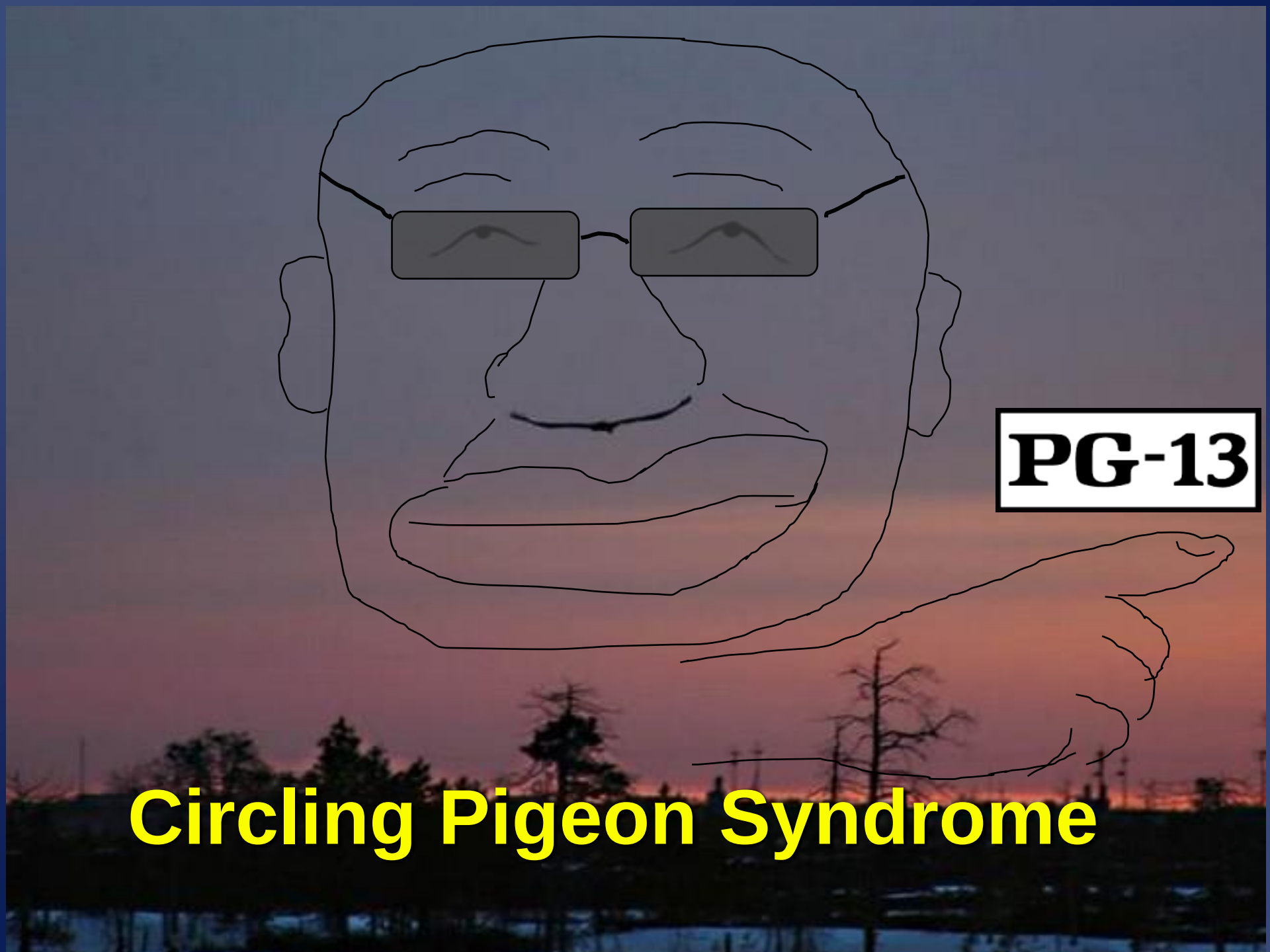
Thermal Cracking	*Fatigue Cracking*	*Rutting*	*Production*







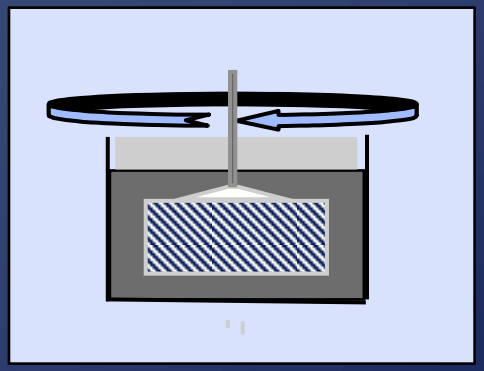
Circling Pigeon Syndrome

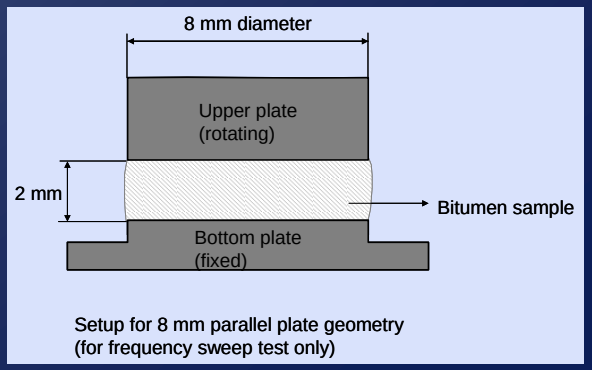

PG-13
Circling Pigeon Syndrome

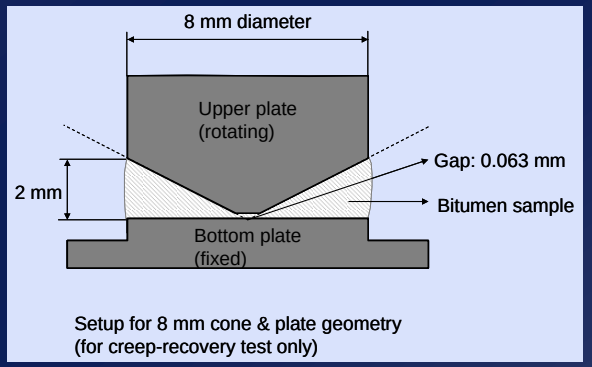
Priority Objectives of PG Binder Working Group 4Mar'15

- Provide industry with working draft protocols, to start binder evaluation
- Identify gaps in protocols that require priority (short term) research
- Identify gaps in protocols that require fundamental research
- Strategic role of SANRAL and Sabita for implementation

DSR Configurations







Cup & Bob Parallel Plate Cone & Plate

- C&B suited to high temperature analysis
- // P variable shear stress across radius, distortion at annulus, but most research
- C&P reduces distortion but ideally 45º needed, eccentricity creates complications

Outcomes of WG Meeting 4

Production & Construction

Spray, Pump, Mix, Pave

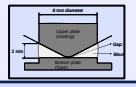
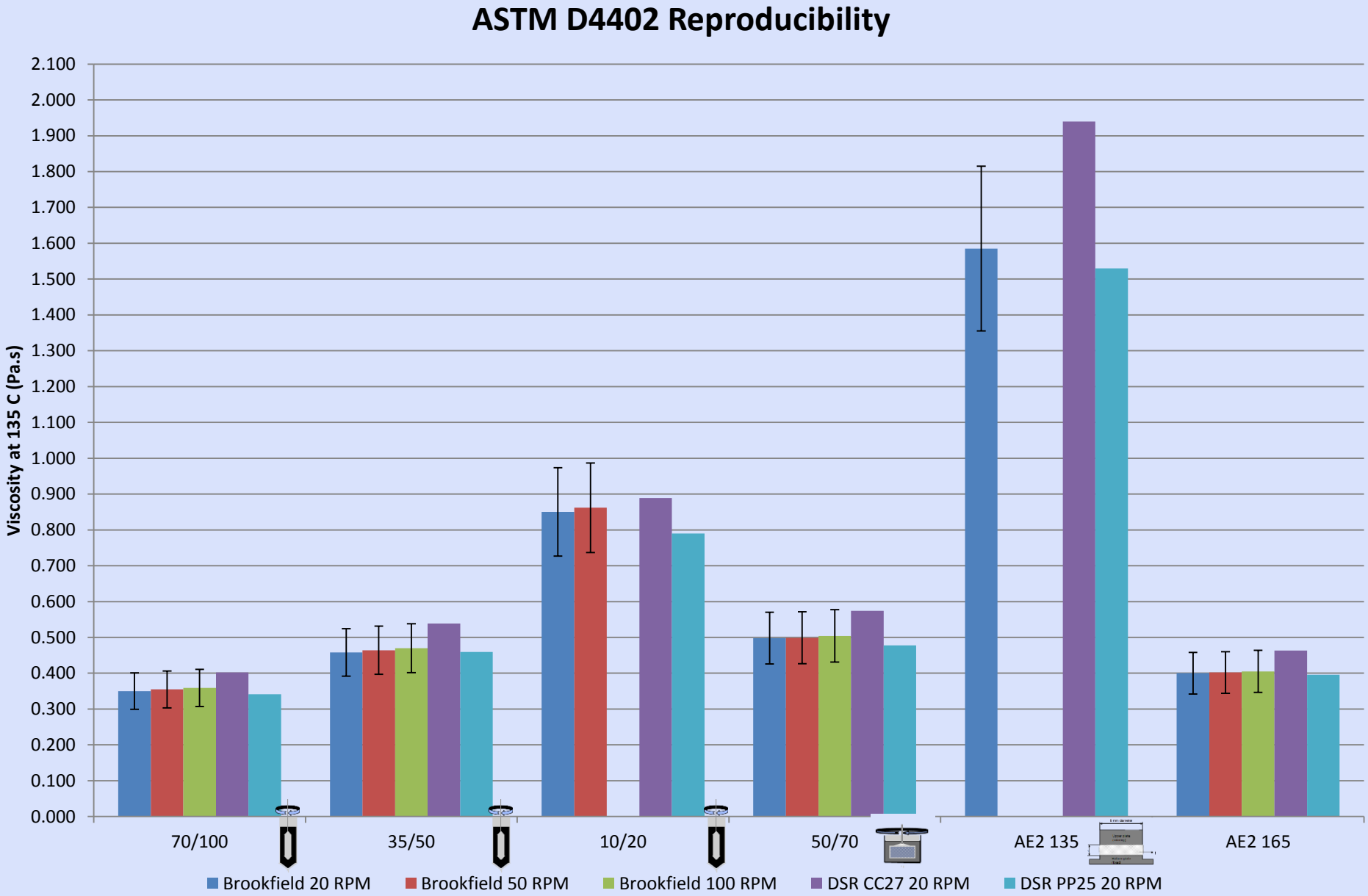
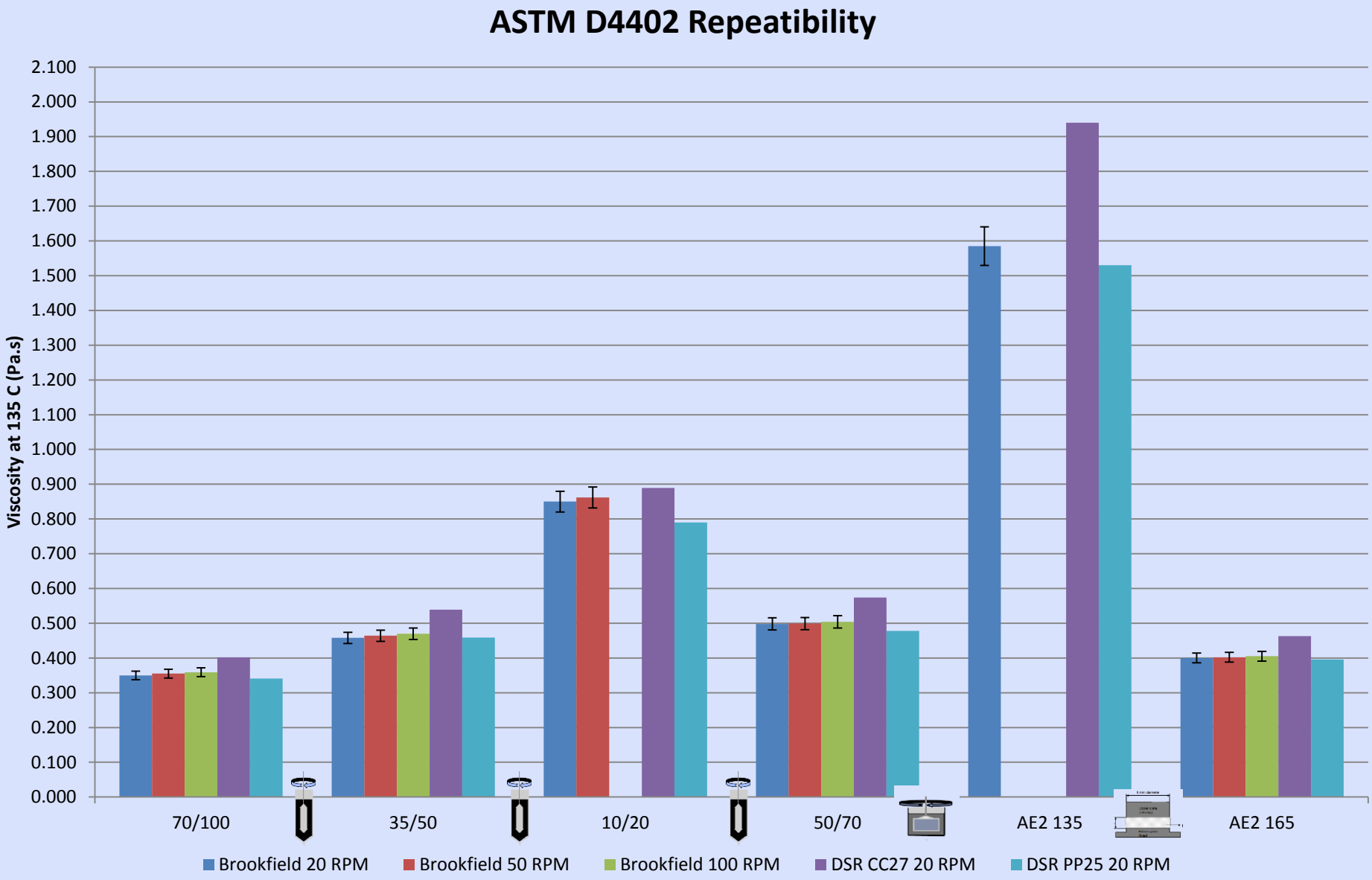
Industry	C&B @ 135°C & 165°C (+ 195°C BR) EN13702 and Anton Paar Method
Research - Priority	Calibration RV vs C&B (JvH) 
Research - Fundamental	Benefits of C&P in same Temp domain Investigate PMBs 
Comments	Workbook ready for implementation JvH

Photo: K Louw

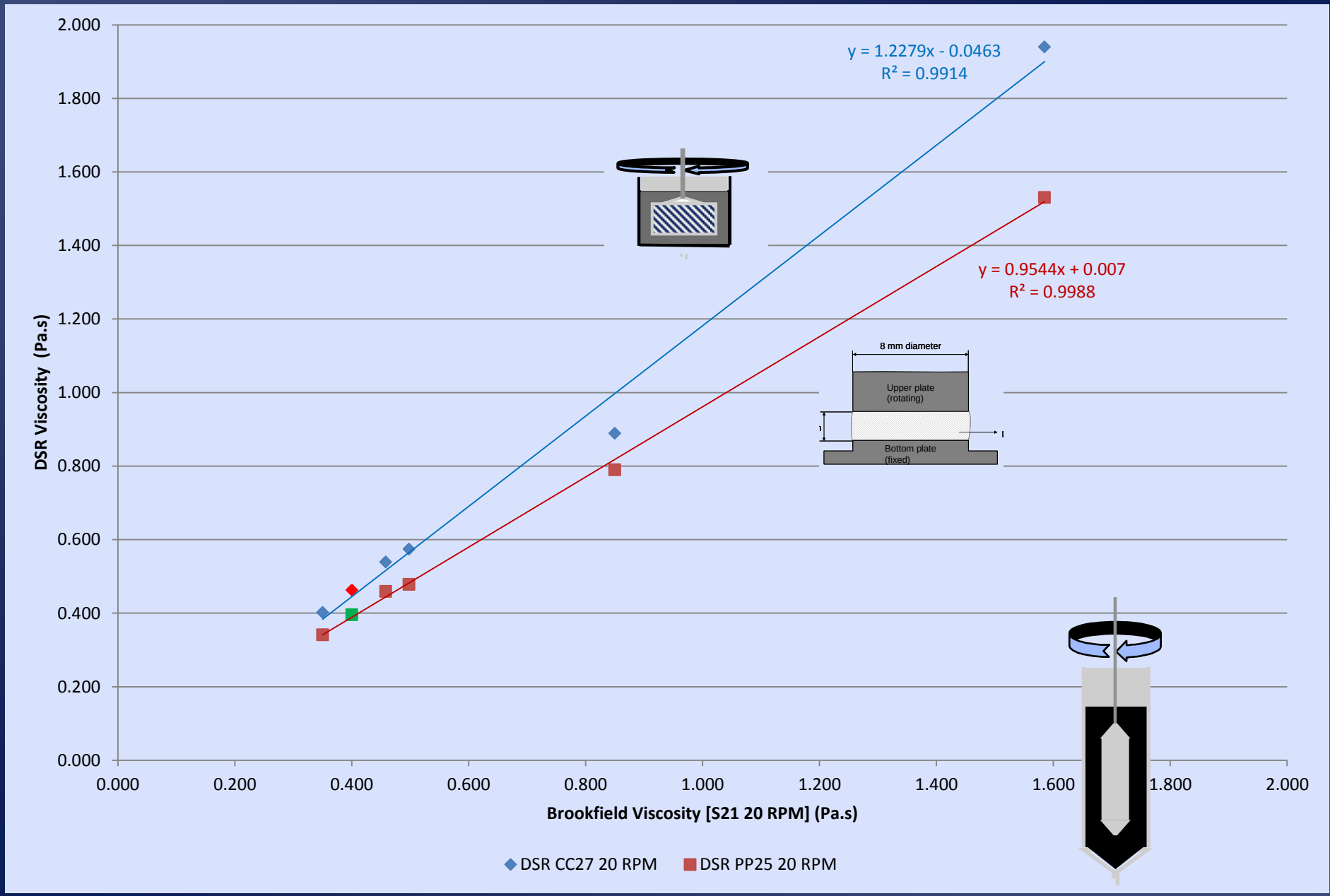
Research Findings (Jacques vH, Tosas)



Research Findings (Jacques vH, Tosas)



Research Findings (Jacques vH, Tosas)

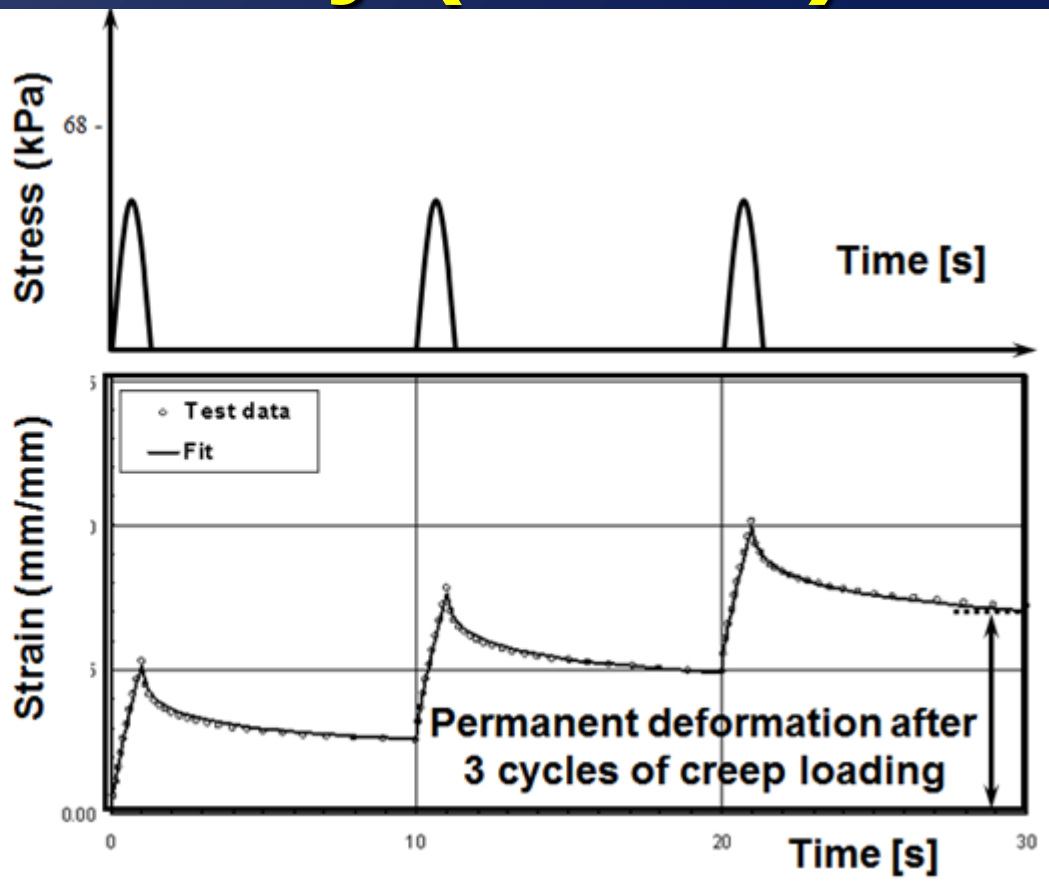


Production temp: BR binder

- CAPSA 2015 paper of Jacques v H
- CC (C&B) and // P comparisons done
- Different results obtained. Why?
- Testing at 195^{o}C
- Gap increased from 1mm to 2mm
- More investigation needed

The new tests : Creep and Recovery (MSCR)

Repeated Creep Loading



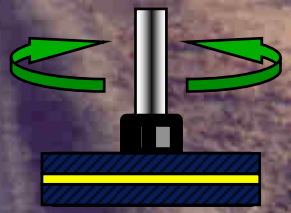
$$J_{nr} = \frac{\text{Ave permanent shear strain (non-recov) per cycle}}{\text{Applied shear stress}}$$

AASHTO TP70

Outcomes of WG Meeting$_2$

Permanent Deformation DCR

Dynamic Creep Recovery



Industry	// Plate @ τ = 10 kPa for 20 cycles CSIR and AASHTO T350 methods
Research - Priority	//P @ τ = 3.2 &10 kPa for 20 cycles //P @ Gap = 2mm for non-hom^g binders
Research - Fundamental	C&P @ τ = 3.2 &10 kPa for 20 cycles Compare J_{nr} to Flow Number (AMPT), MMLS
Comments	Workbook ready, adjust 20 cycles (CSIR, JvH)

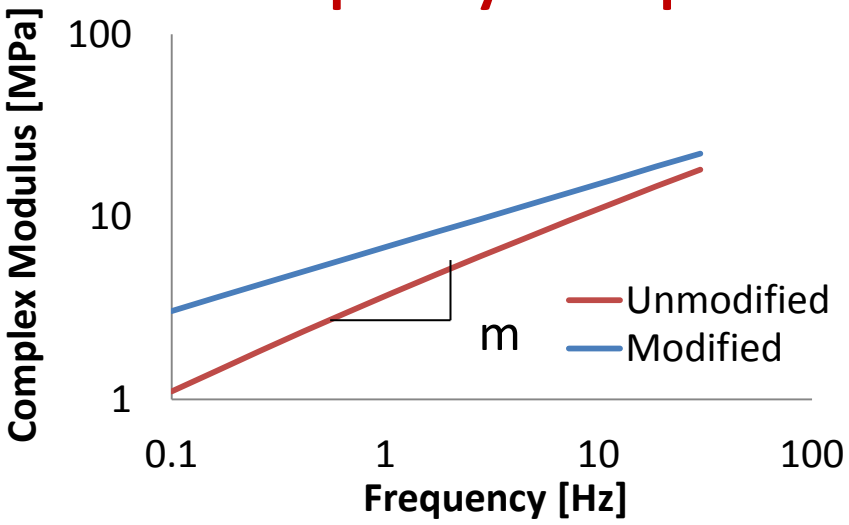
Compare

Photo: G v Zyl

Linear Amplitude Sweep

Rheology

Frequency Sweep

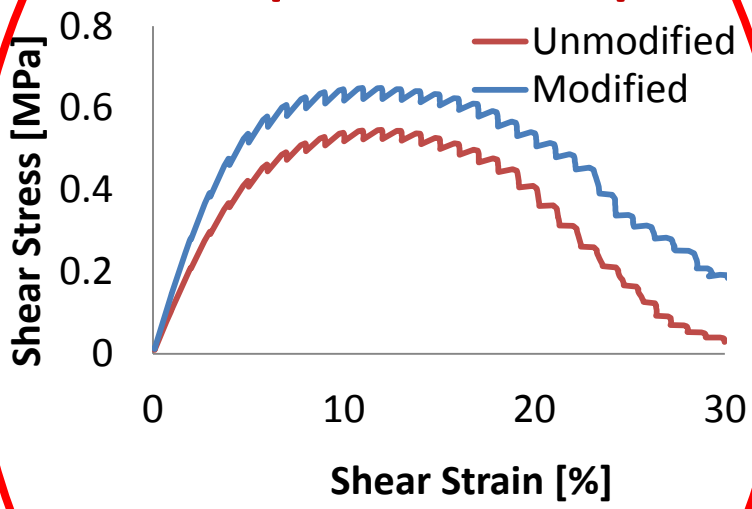


Slope

B

Damage Resistance

Amplitude Sweep



VECD

A

$$N_f = A\,(\gamma_{max})^{B}$$

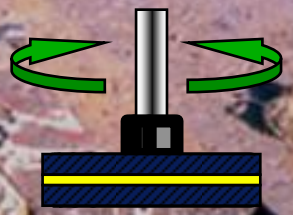
$LAS_{modified}$: Focus on A = Dynamic Yield Energy Parameter, shorter test

(Bahia, 2014)

Outcomes of WG Meeting$_3$

Fatigue BET

Binder Energy Test



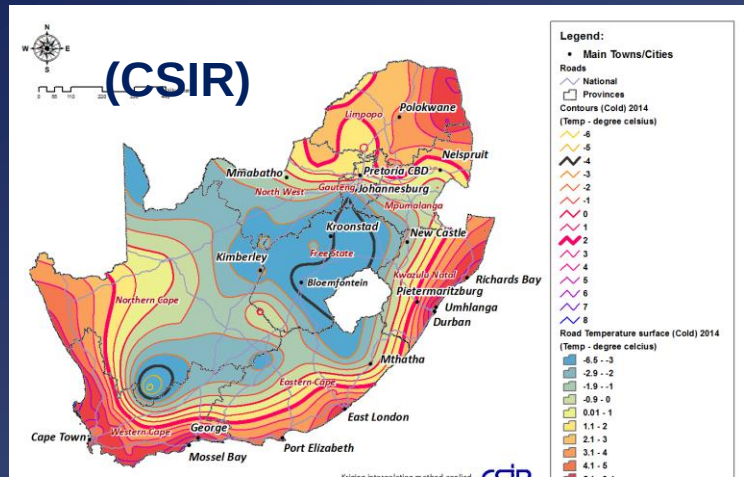
Industry	// Plate @ Strain sweep to post-peak, 30% 10Hz 10°C based on LAS (UWM)
Research - Priority	//P @ Strain sweep to post-peak, ε_{mx}=30% Fr=10Hz, T= 5&15°C, extrap to LT zone
Research - Fundamental	Calibrate BET vs 4P Beam Fatigue Link binder to mix Variables: unmodified and modified Service providers: industry and researchers
Comments	Edited LAS method for BET end May '15 JvH

Photo: CSIR

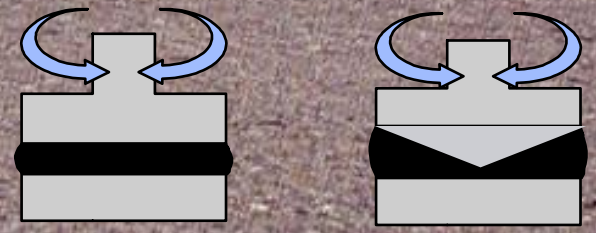
Previous: PG Spec Research$_4$

- **Low Temperature LT Cracking with DSR**
  - Tests in SA originally done at -16C to date
  - Blanket suggestion on LT at -10C for SA (although non-standard, it could be adopted)
  - Creep test @ 5ºC preferred (for s & m)
  - More research in SA, as UWM used cyclic load
  - CSIR method to investigate tanδ method of Soleimani and Hesp

Most of these proposals are still applicable. Test temps & load signals require further research



Outcomes of WG Meeting$_4$
Low Temperature LT Cracking



Industry	No plans for LT protocol at this stage
Research - Priority	None

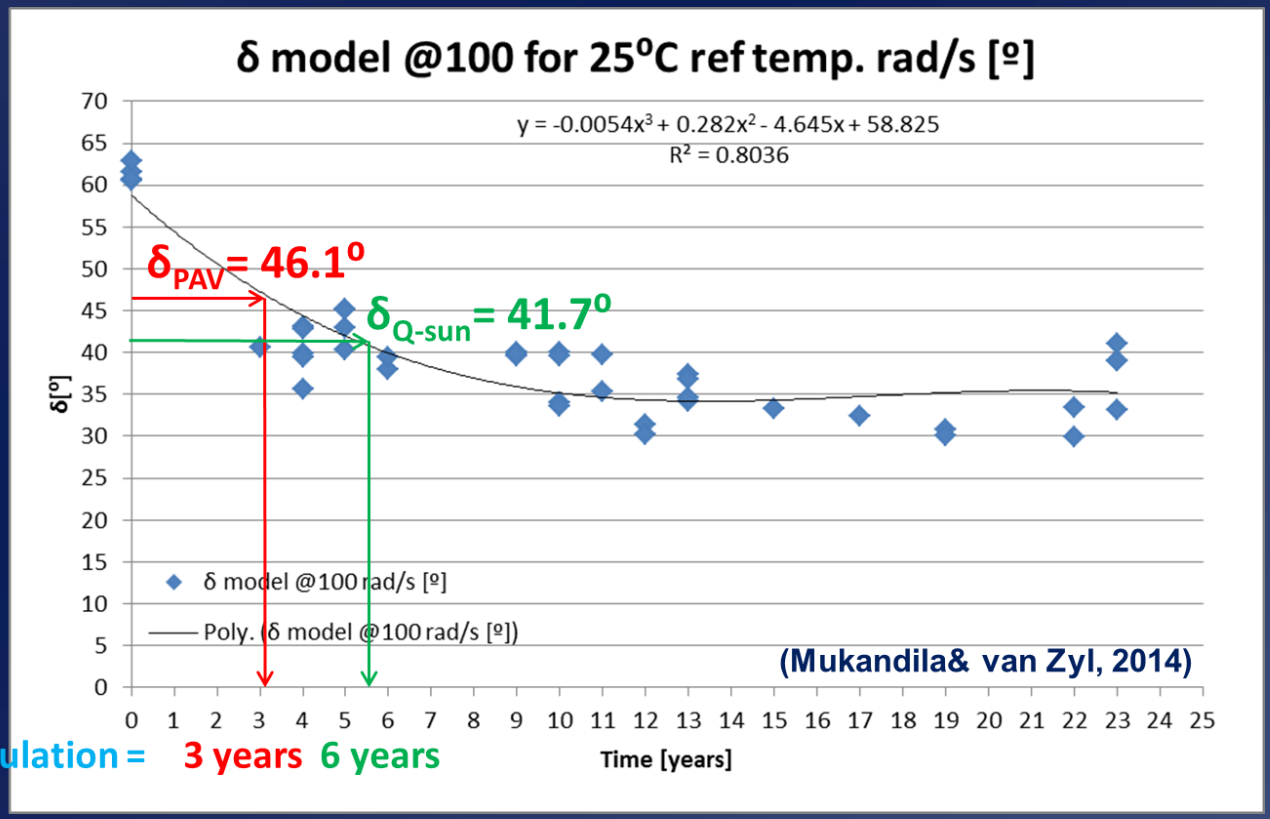
Research - Fundamental	// P or C&P start with cyclic loading followed by monotonic loading (creep-recovery)
	T = 5&15^{o}C with view to extrap. into LT zone

Comments	Possibility of using extended fatigue (BET?) analysis to satisfy LT requirements

Photo: CSIR

Previous Research: Binder Ageing$_6$

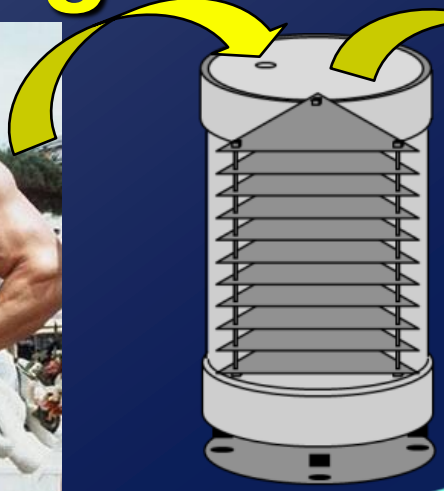
- Long Term Ageing Simulation
  - Standard PAV hopelessly underestimates field ageing e.g. 3 years equivalent not 10 yrs

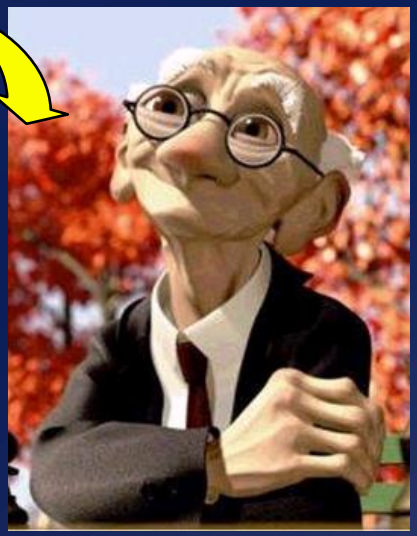


What's wrong with Pressurised Ageing Vessel?

Outcomes of WG Meeting$_1$

Long Term Ageing



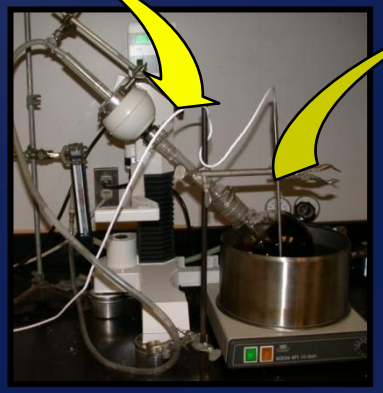


Industry	Standard PAV EN14769 or ASTM
Research - Priority	None
Research - Fundamental	Investigate thinner films in PAV at lower temperatures, with time as variable
Comments	This research is currently being undertaken at CSIR

Findings of Binder Recovery

- **Binder recovery previously reported**
  - **Abson method (CSIR) and Rotor Vapour Method (CSIR +other labs). NCHRP paper.**
  - **Report by Georges Mturi**
    - **Centrifuge – how many repeats?**
    - **FTIR or another method to check if filler is out**
  - **Standardise Rotor Vapour for SA (Georges, Hennie, Herman, Wynand)**

Outcomes of WG Meeting$_1$
Binder Recovery



Industry	Rotary Evaporator
Research - Priority	Research complete at CSIR. GM to draw up protocol for Rotor-Vapour based on research
Comments	Industry awaiting protocol. Progress!

In Summary

- DSR still eminently suited for PG
- Different stages of implementation
  - Manufacture/Applic: Protocol ready
  - Deformation resistance: Protocol ready
  - Fatigue: Priority research required
  - LT Cracking: Fundamental research
- New Proposal prepared for SANRAL
  - Address research needs

Performance Grading has limits…

Thank you!!