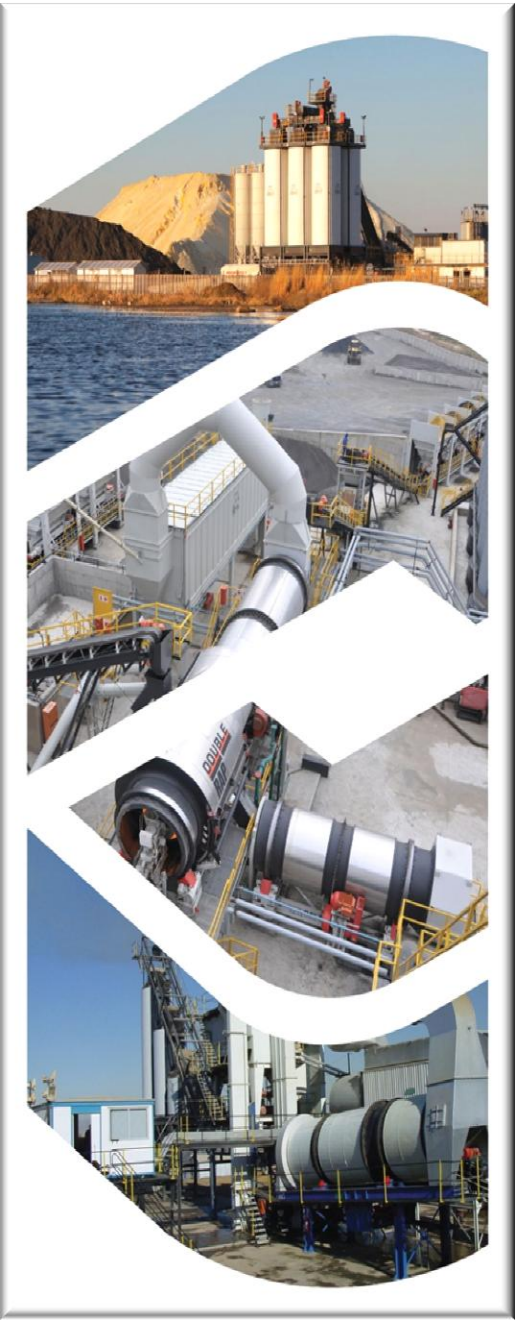


Revision of Sabita Manual 19 Bitumen Rubber Asphalt

26th Road Pavements Forum

06 November 2013

Herman Marais

SABITA Manual 19

sabita

Project Brief

- Determine whether the guidelines for the design of bitumen rubber mixes as contained in Sabita Manual 19:
  - Are still in line with international best practice; and
  - If improvements can be made to the design methods to prevent recurrence of the problems with bitumen rubber mixes encountered on the GFIPs.

Approach

- SABITA appointed CSIR;
  - Erik Denneman – Lead author;
  - Assisted by Herman Marais (MUCH Asphalt) and Lucas-Jan Ebels (UWP Consulting)
  - Piet Myburgh
- Obtain information w.r.t. GFIP failures
- Study tour to the USA
- Desk-top study
- Sabita appointed Soillab to do BR Blend and BRA testing

Study Tour to USA

Aim of the tour was to identify differences between South Africa and international practice in:

- Design
- Manufacture
- Specification
- Placement

Study tour

- Main findings from the study tour:
  - The main driver for the use of BR in California is legislation.
  - Extensive use of terminal blends (fine rubber crump blended at the refinery)
  - The main application of BR in California is in gap graded mixes, followed by open graded mixes
  - The layer thicknesses for gap graded mixes is generally 25 – 50 mm, open graded mixes in 12.5 – 25 mm
  - BR has been used extensively in Arizona, mostly single type of application, 20 mm open graded bitumen rubber asphalt overlay for its concrete pavements

Study tour

- Main findings (continued)
  - Use of SAMIs has been discontinued
  - Gap graded mixes in Arizona are more durable than open graded mixes
  - The use of polymer modified BR binders is increasing, main reasons:
    - reduction of flushing, and
    - increased adhesion to the aggregate
  - The viscosity of the BR binder generally lower than in South Africa (fewer and coarser rubber crumbs, which take longer to react, more stable viscosity)

Study tour

- Main findings (continued)
  - Natural rubber content in SA (min. 25%) higher than in USA
  - In California, the Hveem method is used in the design of BR mixes, in Arizona Marshall (165°C, 75 blows)
  - Move towards the use of performance related specifications

Desktop study: crumb rubber grading

% passing sieve size [mm]	TG1 / manual 19	Caltrans Scrap tire	Caltrans High natural rubber	Tx DOT Grade A	Tx DOT Grade B	Tx DOT Grade C	ADOT Type A	ADOT Type B	FDOT Type A	FDOT Type B	FDOT Type C
2.36		100		100			100				
2.00		98-100	100	95-100	100		95-100	100			
1.18	100	45-75	95-100		70-100	100	0-10	65-100			100
0.600	40-70	20-45	35-85		25-60	90-100		20-100		100	70-100
0.425						45-100					
0.300		0-6	0-10	0-10				0-45	100	40-60	20-40
0.150		0-2	0-4						50-80		
0.075	0-5	0	0-1		0-5			0-5			

Desktop study: binder properties

Specification	TG1 / manual 19	Caltrans Type 2	Tx DOT Grade I	Tx DOT Grade II	Tx DOT Grade III	ADOT Type 1 (hot)	ADOT Type 2 (mild)	ADOT Type 3 (cold)	FDOT
Rubber content by mass of binder (%)	20-24	≥ 15.2	≥ 15	≥ 15	≥ 15	≥ 16.7	≥ 16.7	≥ 16.7	≥ 10.7
Grade of base bitumen	Pen 80/100 (typical)	AR-4000	PG 58-28	PG 58-28	PG 58-28	PG 64-16 Pen 60/70	PG 58-22 Pen 85/110	PG 62-28 120/200	
Extender oil by mass of binder (%)	≤ 3	2.5-6.0	Not used	Not used	Not used	Not allowed	Not allowed	Not allowed	Not used
Reaction temperature (°C)	170-210	190-226				163-190	163-190	163-190	150-175
Minimum reaction time	45	45				60	60	60	15
Storage life (hours)	6								
Minimum Ring&Ball softening point (°C)	55-65	52*-72*	≥ 57	≥ 54	≥ 52	≥ 57	≥ 54	≥ 52	
Resilience at 25°C (%)	13-40	≥ 18*				≥ 30	≥ 25	≥ 15	
Penetration (200 g) 60s 4°C 1/10mm						10	15	25	
Penetration (150 g) 5s 25°C 1/10mm		25-70*							
Viscosity, Haake 190°C Pa s	2.0-5.0	1.5-4.0*	1.5-5.0	1.5-5.0	1.5-5.0	1.5-4.0	1.5-4.0	1.5-4.0	
Flow (mm)	10-50								
Compression/recovery (%)	5 min >80 1 hour > 70								

* Measured after 45 minutes

Desktop study: Bitumen rubber

Recycled Tyre Rubber Modified Bitumens for road asphalt mixtures: A literature review

Davide Lo Presti

Nottingham Transportation Engineering Centre,
University of Nottingham, Nottingham, UK

SOILLAB

Part of the SMEC Group

REPORT ON: BITUMEN RUBBER BLENDS DONE FOR SABITA FOR THE REVISION OF SABITA MANUAL 19

July 2013

PREPARED FOR

Sabita

Rosmed Suite 68

Private Bag X21

Howard Place, 7450

South Africa

sabita

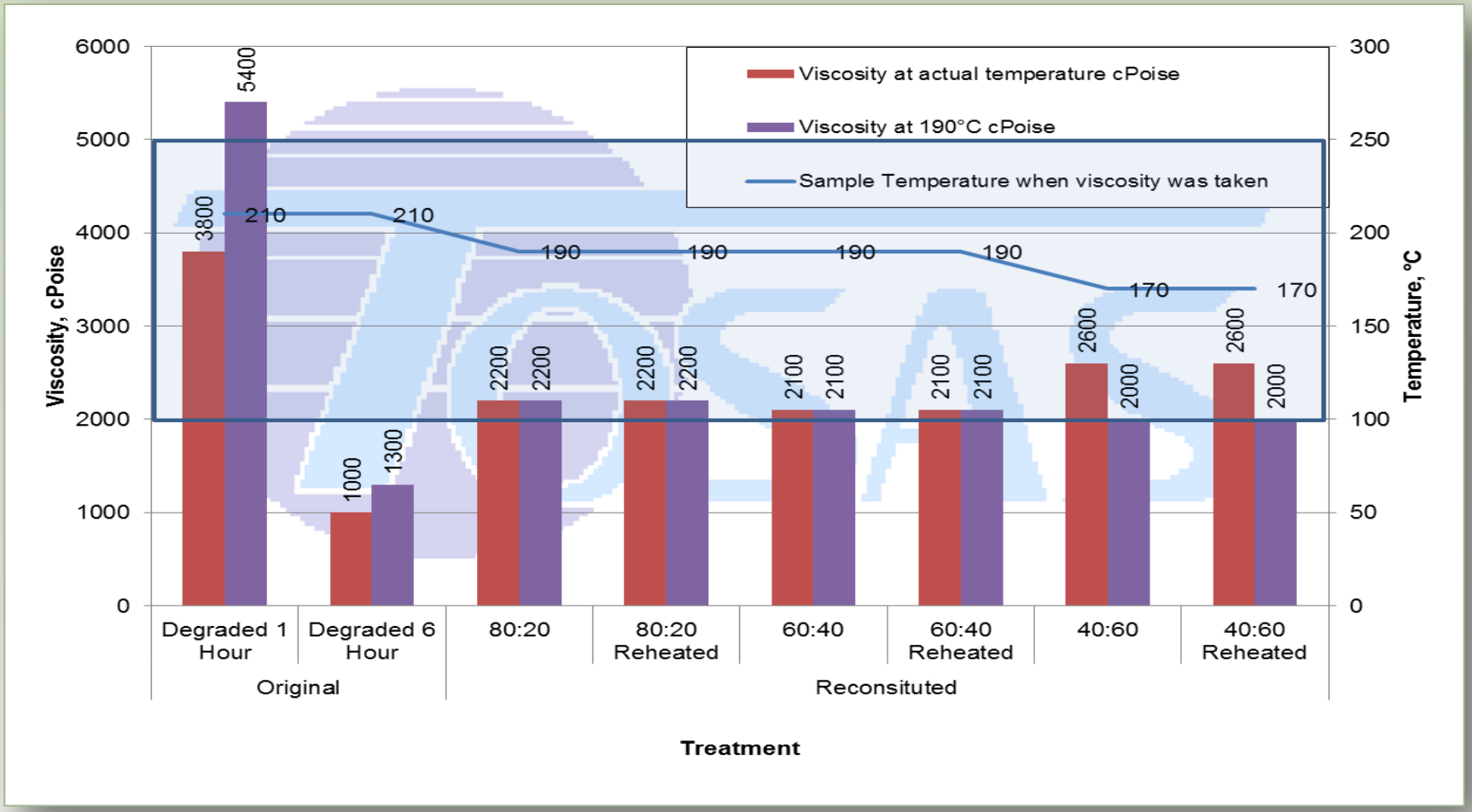
Soillab Testing done for Sabita

- **Task A - Addition of degraded bitumen rubber as percentage to fresh blends**

  The blends consisted of 20% , 40% and 60% of the degraded bitumen rubber incorporated in fresh blend
- **Task B – Addition of rubber crumbs to degraded bitumen rubber**

  Blends were prepared with 2.5%,5.0% and 10.0% additional rubber in degraded blend at 190°C.
- **Task C - Evaluation of coarser crumbs on bitumen rubber properties (***Arizona Crumb Grading and Blend vs. RSA Bitumen Rubber)*

Task A – Reconstitution of over-reacted blend (New blend with Old blend)



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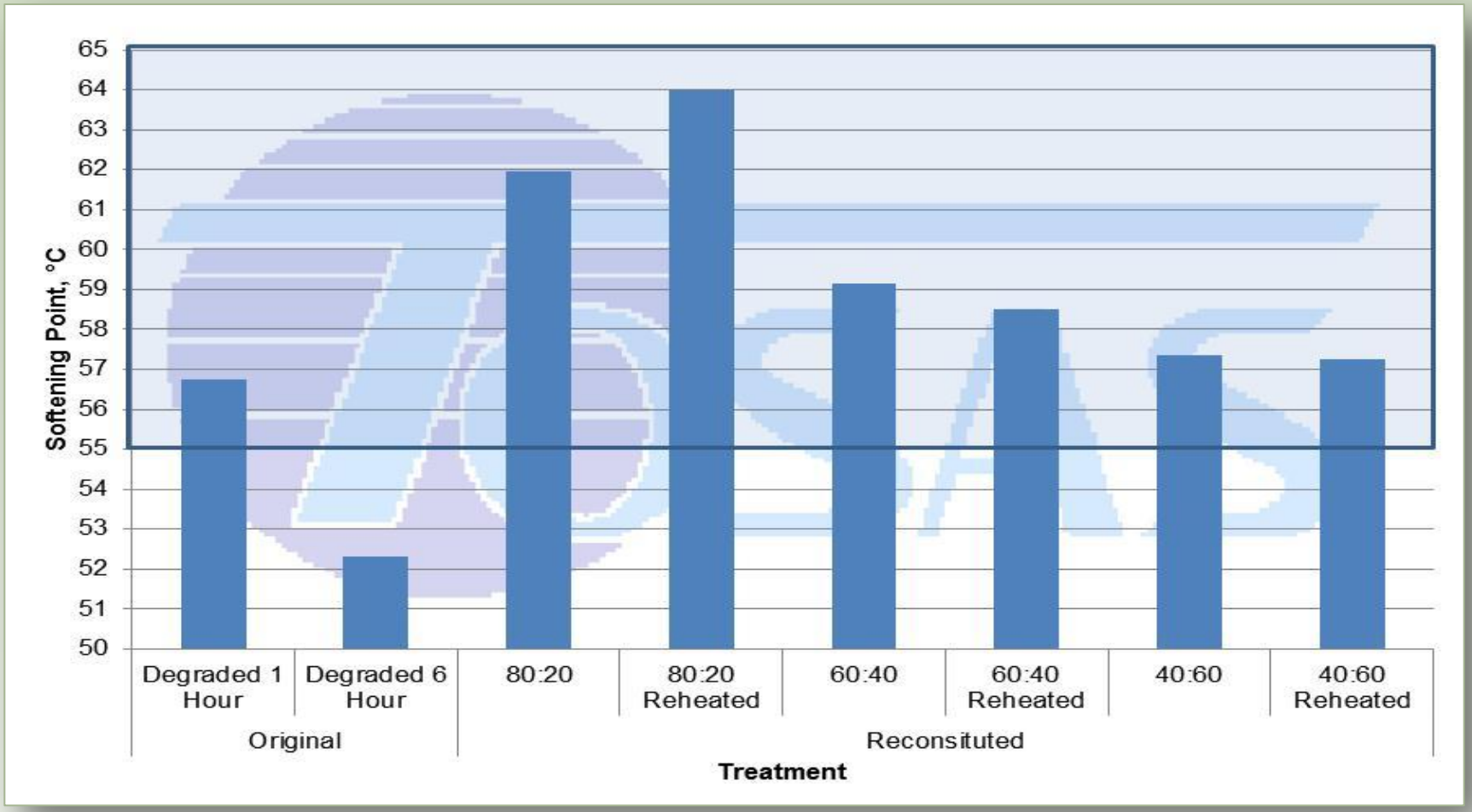
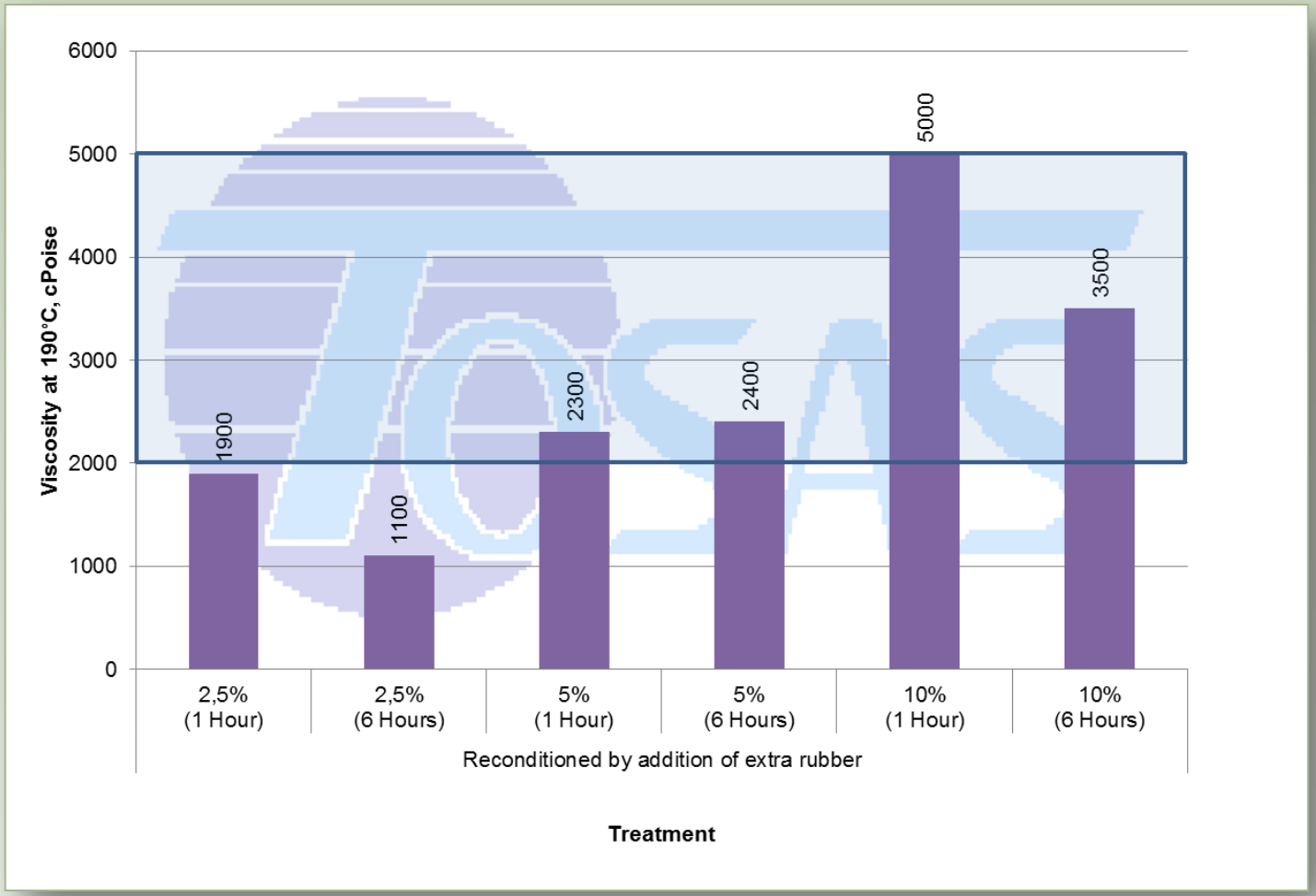


Task A – Reconstitution of over-reacted blend (New blend with Old blend)

Note that there was no compensation made for the level of degradation by the addition of "extra" rubber crumbs, as would be the case in practice. However some research work was done in this regard by the industry.

VISCOSITY - RUBBER CRUMB RELATIONSHIP TABLE	
Viscosity @ 190°C (dPa)	% Rubber Crumb to be Added
2500	2 - 4 %
2250	3 -5 %
2000	4 - 6 %
1750	5 - 7 %
1500	6 - 8 %
1250	7 -9 %
1000	8 - 10 %
750	9 -11 %
500	10 - 12 %

Task B – Reconstitution of over-reacted blend by addition of rubber crumbs



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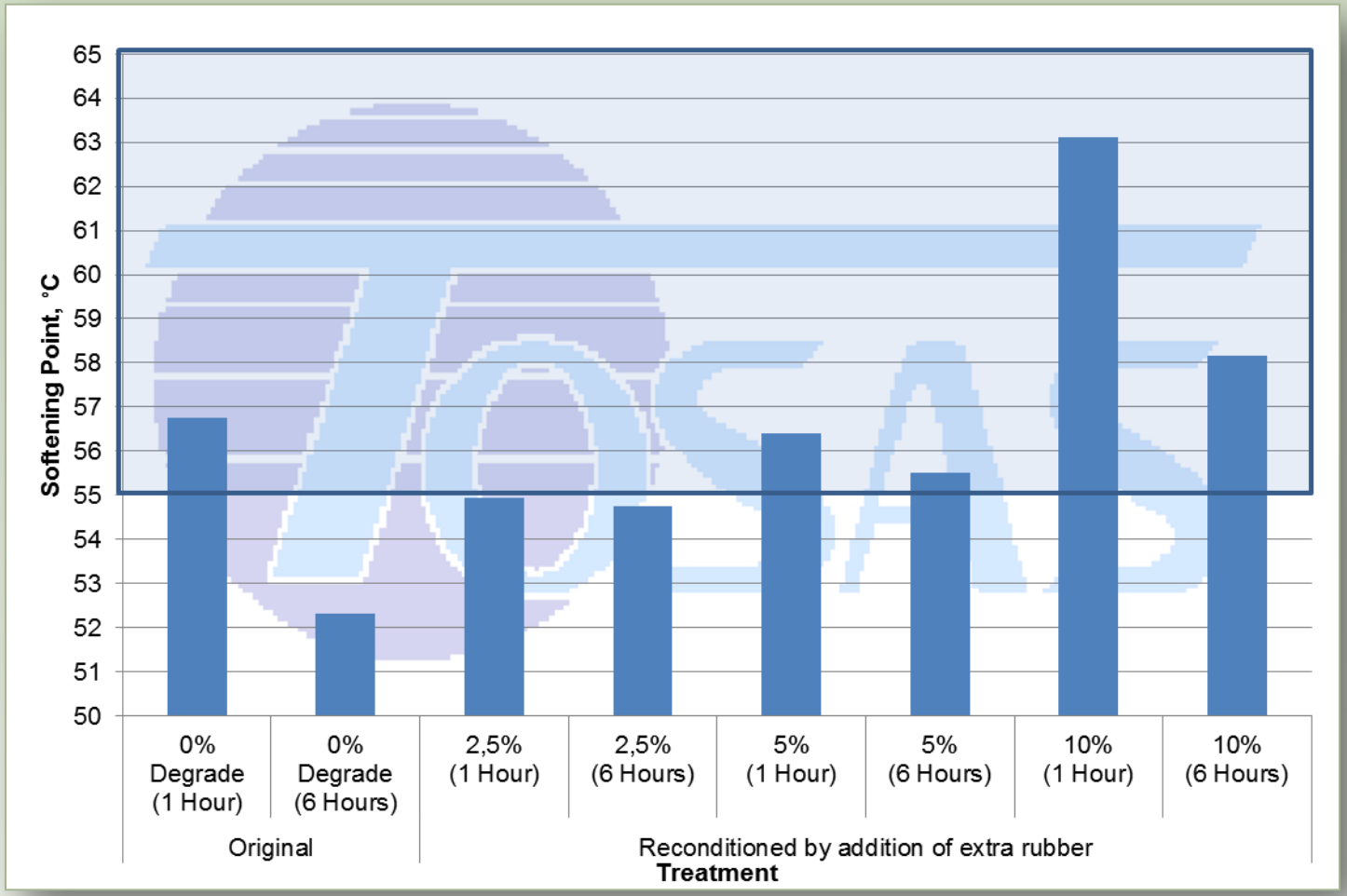

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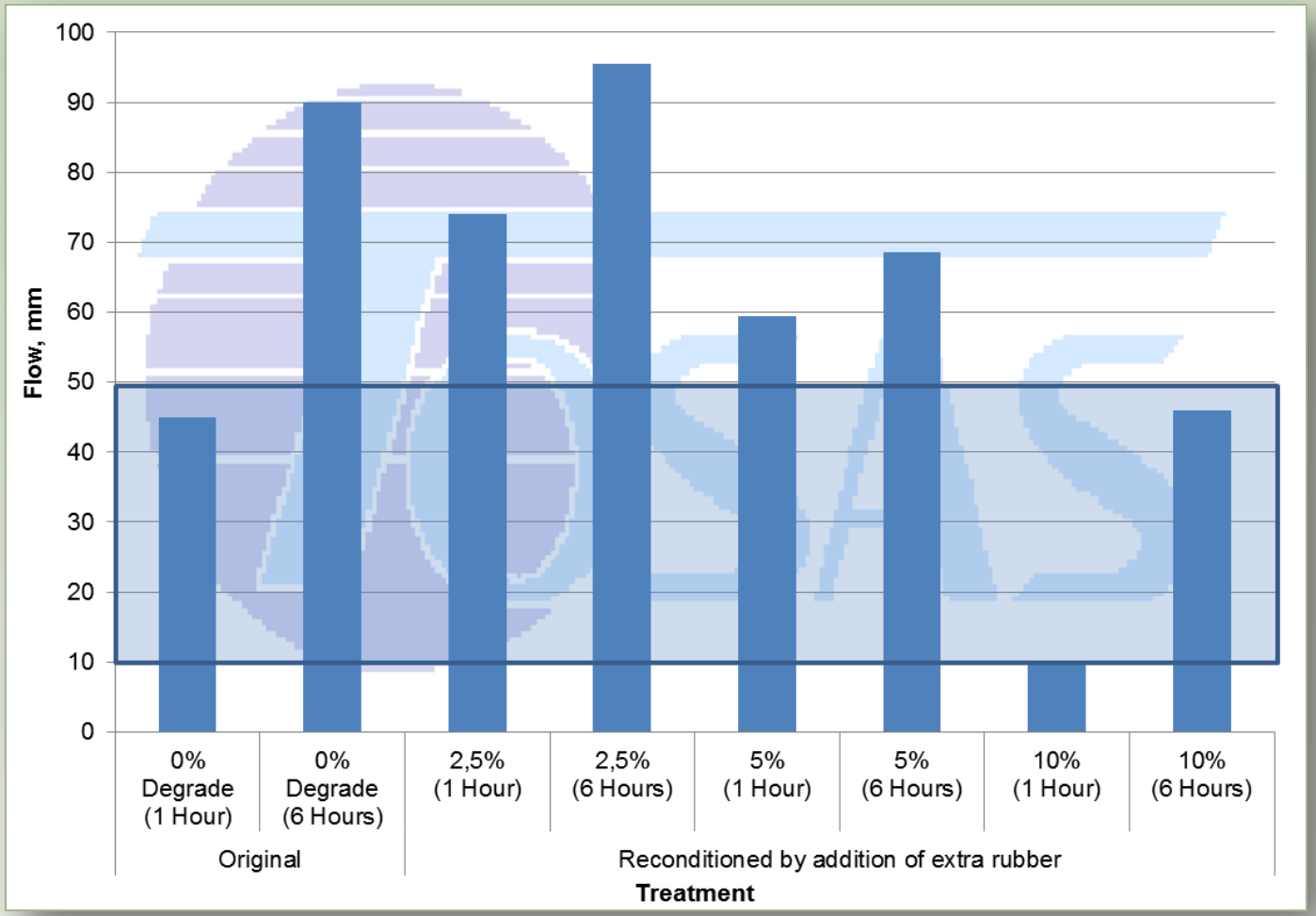
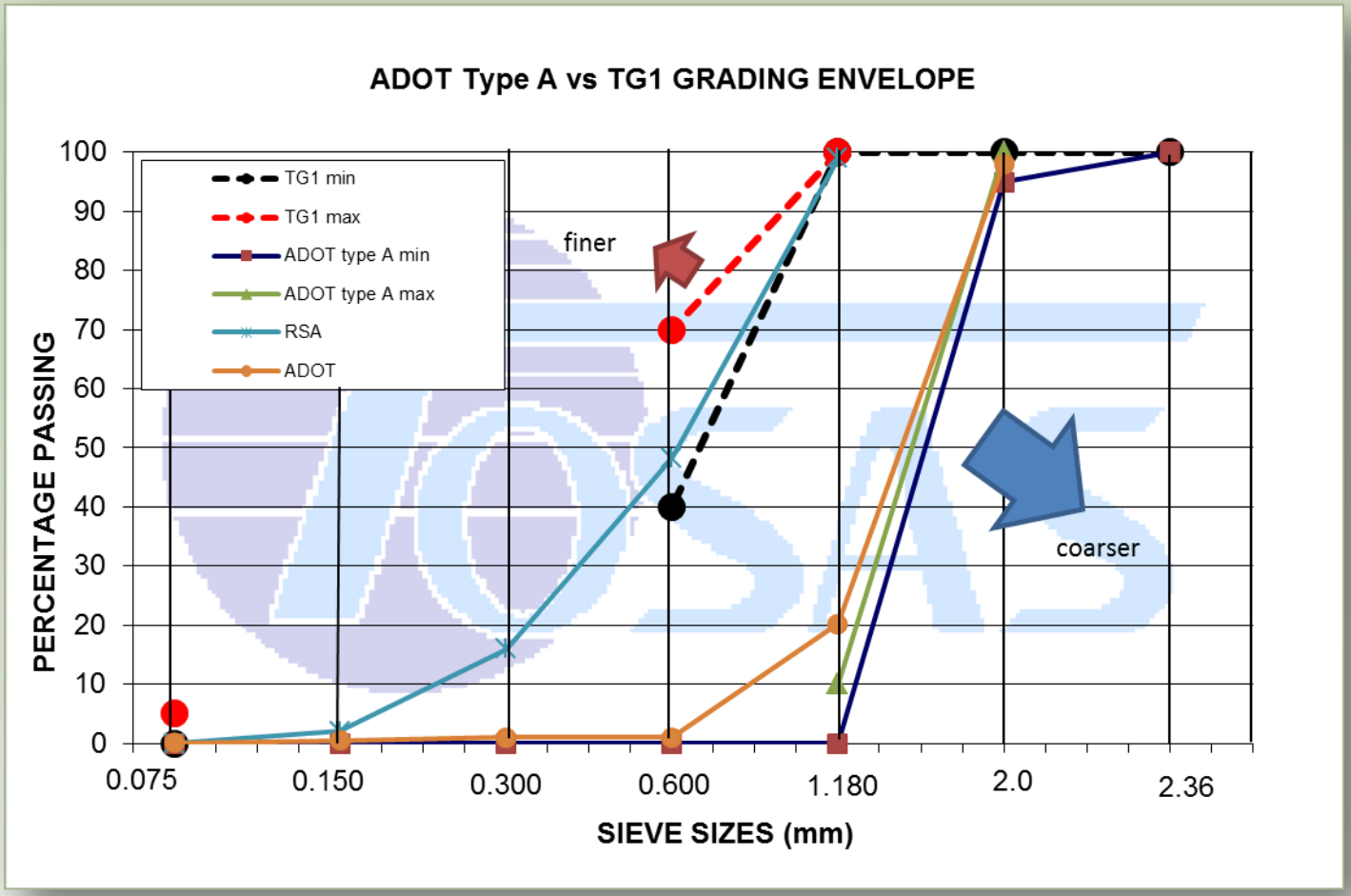


Task C – Evaluation of Arizona Crumb grading



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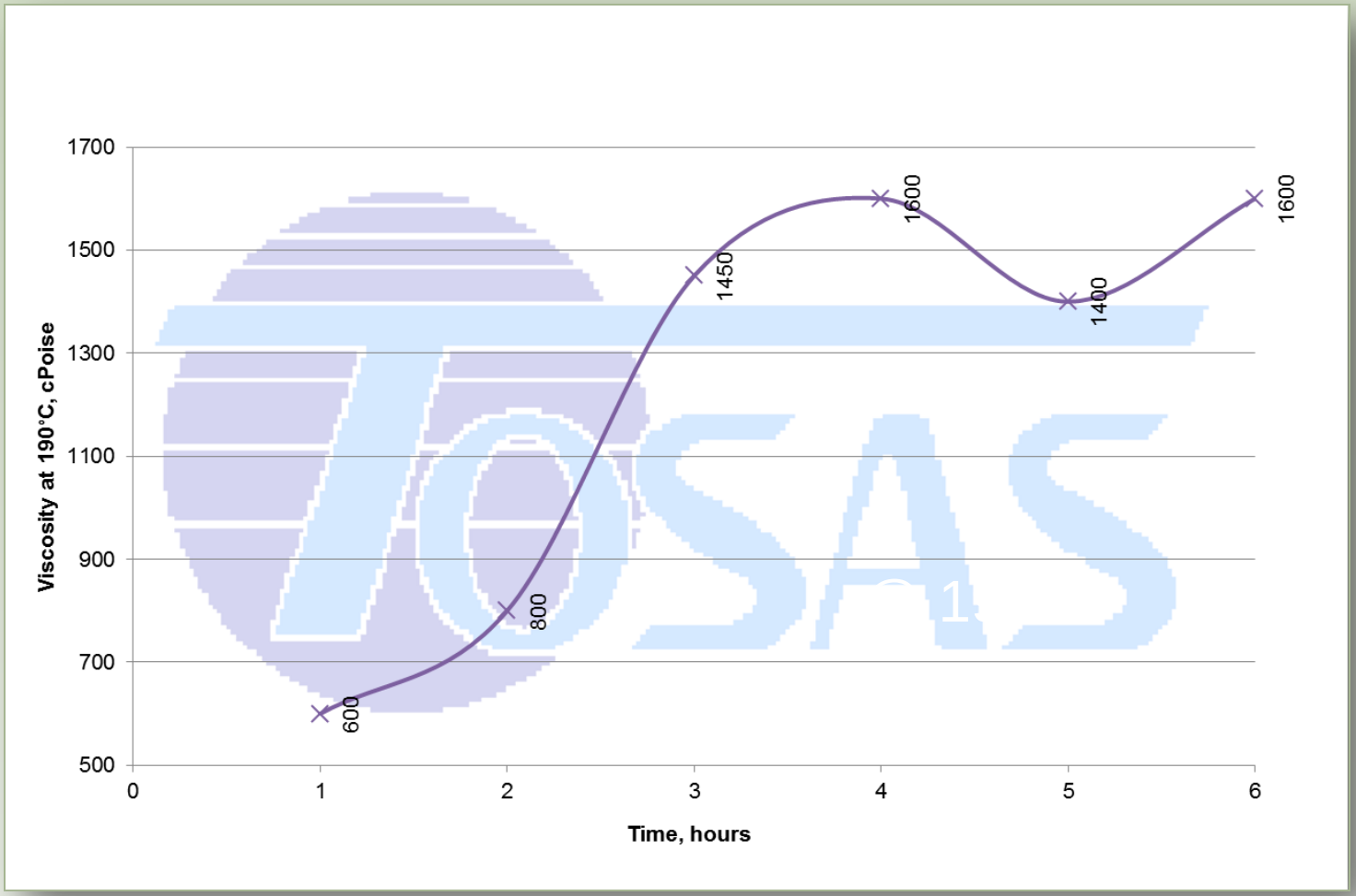

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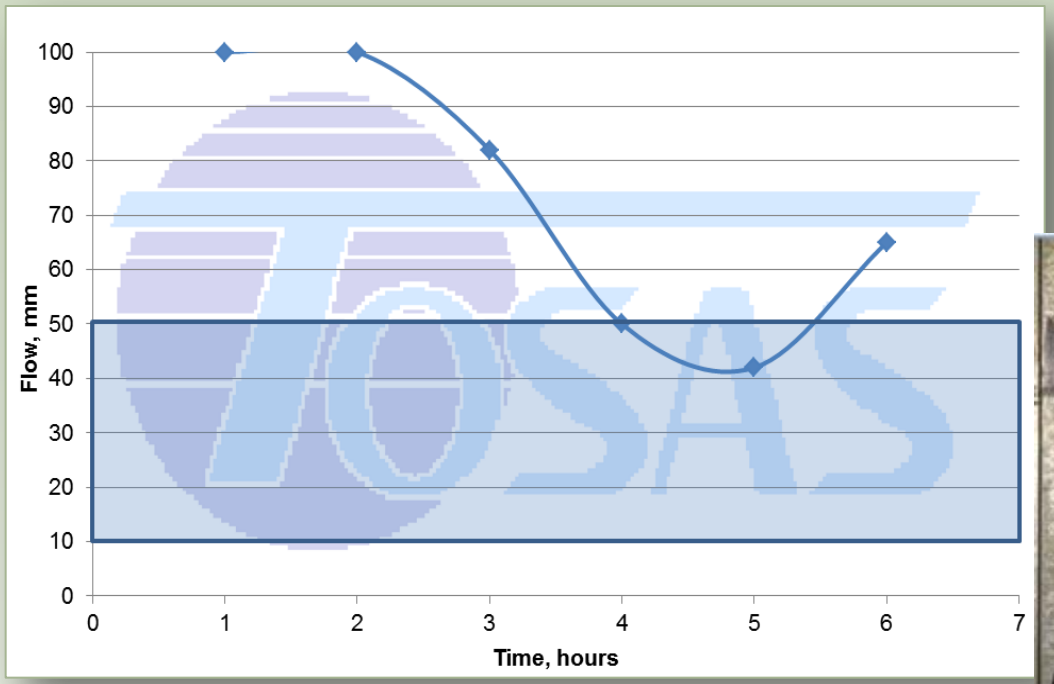


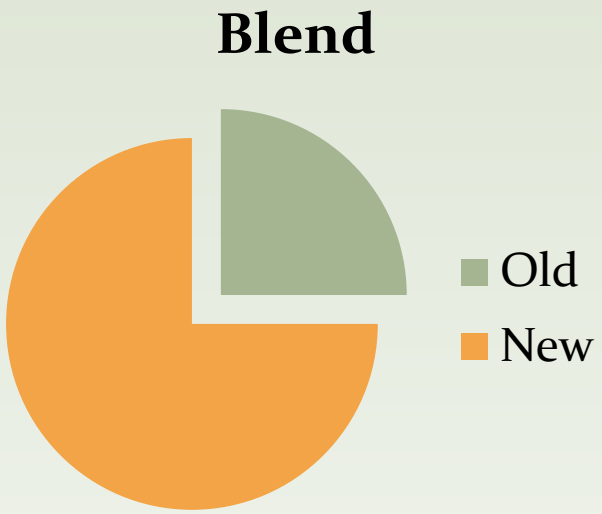
Task C – Evaluation of Arizona Crumb grading

Blend	Property Blend	Binder content %			
		5.5	6.0	6.5	7.0
Original	BRD	2.339	2.358	2.336	2.337
Adot		2.325	2.348	2.344	2.333
NCRT		2.336	2.346	2.335	2.319
Original	Rice	2.563	2.546	2.528	2.511
Adot		2.560	2.540	2.520	2.500
NCRT		2.567	2.546	2.526	2.506
Original	Voids	8.7	7.4	7.6	6.9
Adot		9.2	7.6	7.0	6.7
NCRT		9.0	7.9	7.6	7.5
Original	Gyratory Voids	6.8	4.8	3.8	2.8
Adot		8.1	5.0	4.2	2.3
NCRT		7.3	5.8	5.2	4.7
Original	Film Thickness	15.8	17.4	19.0	20.6
Adot		16.0	17.7	19.5	21.2
NCRT		15.6	17.3	19.1	20.9
Original	ITS	881	706	627	617
Adot		614	586	547	620
NCRT		768	864	869	769
Original	VMA	18.9	19.4	20.6	21.1
Adot		20.1	19.8	20.3	21.1
NCRT		19.7	19.8	20.6	21.5

Recommendations

Recommendations

- The reconstitution methodology can be revised in Sabita Manual 19 subject to conformance of the reconstituted binder to end spec requirements as per TG-1 [7]The reconstitution approach will be a combination of the two methodologies (Task A and Task B) This Sabita research project has emphasised and substantiated the current well-balanced practice of reconstitution.



Recommendations

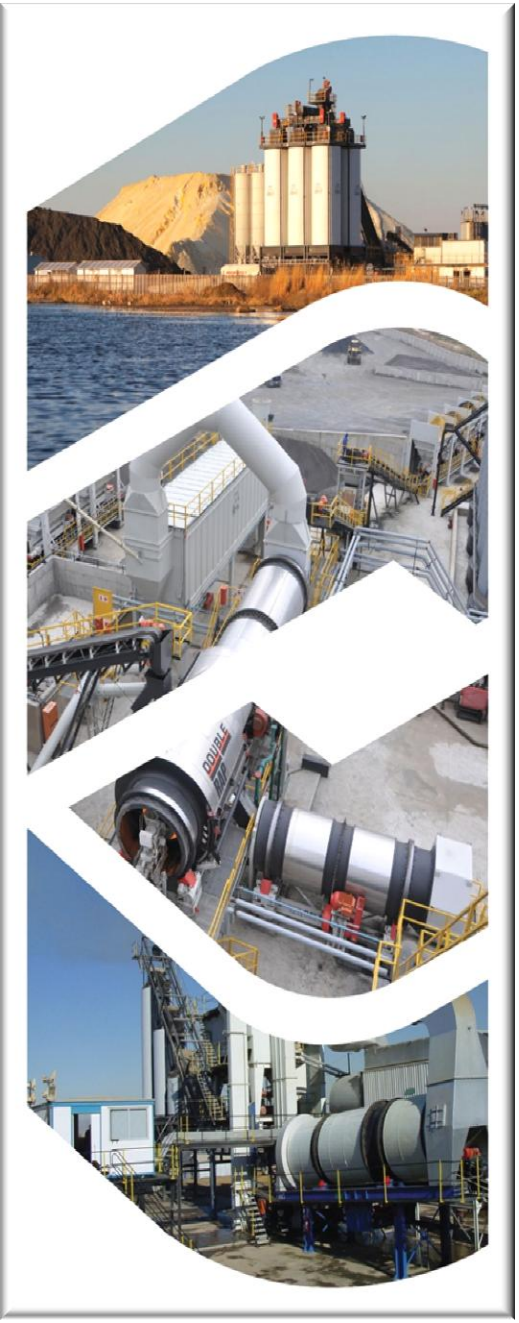
- The Arizona Type A rubber crumbs used in a 18% (ADOT Type 1) blend is not properly constituted to produce a product that will meet the current high performance level of the AR-1 type product that has worked for more than 25 years effectively in South Africa.

Recommendations

- General Improvements to Manual 19
  - Inclusion of statement how to deal with bitumen rubber modified binder that has gone out of specification (adding additional rubber and /or re-blending)
  - Include some of the more pertinent NIOSH health and safety recommendations
  - Investigate boundary in grading between open-graded and semi-open-graded mixes and use new SANS sieves

Recommendations

- General recommendations:
  - Further research into the use of ~~terminal blends~~ *no agitation bitumen rubber* in the application of BRA
  - Investigate the use of polymer modified bitumen rubber binders
  - More detailed investigation into why the use of SAMI's is discontinued in the USA and possible implications for RSA



Much Asphalt

Thank you

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Excellence delivered with integrity