

# Revision of Sabita Manual 19 Bitumen Rubber Asphalt

23<sup>rd</sup> Road Pavements Forum

09 May 2012

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# SABITA Manual 19



# 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)
- Obtain information w.r.t. GFIP failures
- Study tour to the USA
- Desk-top study



# Current Status



## CSIR Contract Report for Review with SABITA

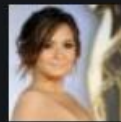




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**Elvis exhibit melts Lisa Marie**



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SA Time: 06 February 2012 16:06:18

# Warping toll road shock

August 26 2011 at 09:56am  
By ANGELIQUE SERRAO

Large chunks of South Africa's brand-new freeway system are "warping" so badly, they will have to be cut up and relaid.

Motorists who have travelled along the N1 North between the Beyers Naudé and Malibongwe off-ramps may have noticed the yellow line on the left-hand lane looking very strange.

Instead of a flat road with a straight line, vehicles move along a bumpy, uneven surface and the yellow line curves so dramatically, it looks like a child was given a yellow crayon and drew loopy lines on the side of the road.

The affected sections are part of the SA National Roads Agency Ltd's R20 billion toll road network, which will see average motorists paying 40c/km to use.

Two independent sources who work in construction told The Star that Sanral was aware there was a problem <http://www.iol.co.za/tonight/music/elvis-exhibit-melts-lisa-marie-1.1228273> as a dispute between the contractor and the agency about who



INDEPENDENT NEWSPAPERS  
The warping of the tarmac is clearly visible on the yellow line on the N1 near Cresta, Joburg, due to the road surface shifting. Photo: Timothy Bernard

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# Reports GFIP failures

- The intention of this study **was not** to identify the dominant cause of the BRASO problems on the different GFIP sections
- However, factors that may have contributed to the failures include:
  - The grading envelope for BRASO used in South Africa is wide compared to international practise
  - VMA and VFB used internationally is generally higher
  - The mixing and reaction of the rubber crumb and binder is generally done at lower temperatures internationally
  - The need for the use of extender oil is questioned

# Reports GFIP failures

- VIM of the BRASO was sensitive to:
  - small changes in grading
  - changes in the binder viscosity
- High storage temperatures may lead to binder degradation
- Possible aggregate breakdown of aggregates during compaction on concrete substrata
- Variations in grading
- The binder high application rate of SAMI's
- Correlation between flushing and target binder content
- Marshall design approach



# 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



# 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

- 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)

- 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



# 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			

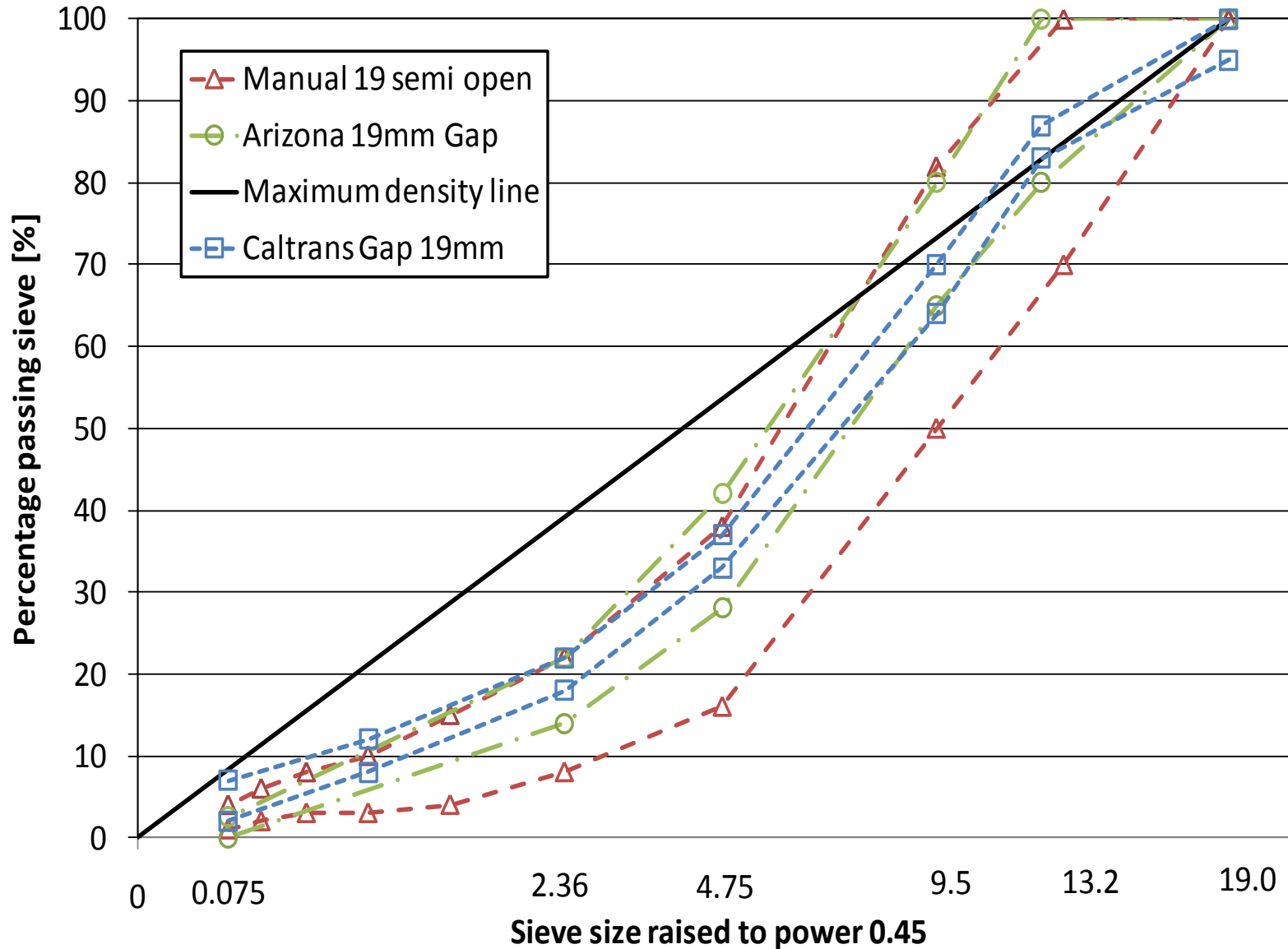
# Desktop study: binder properties

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								

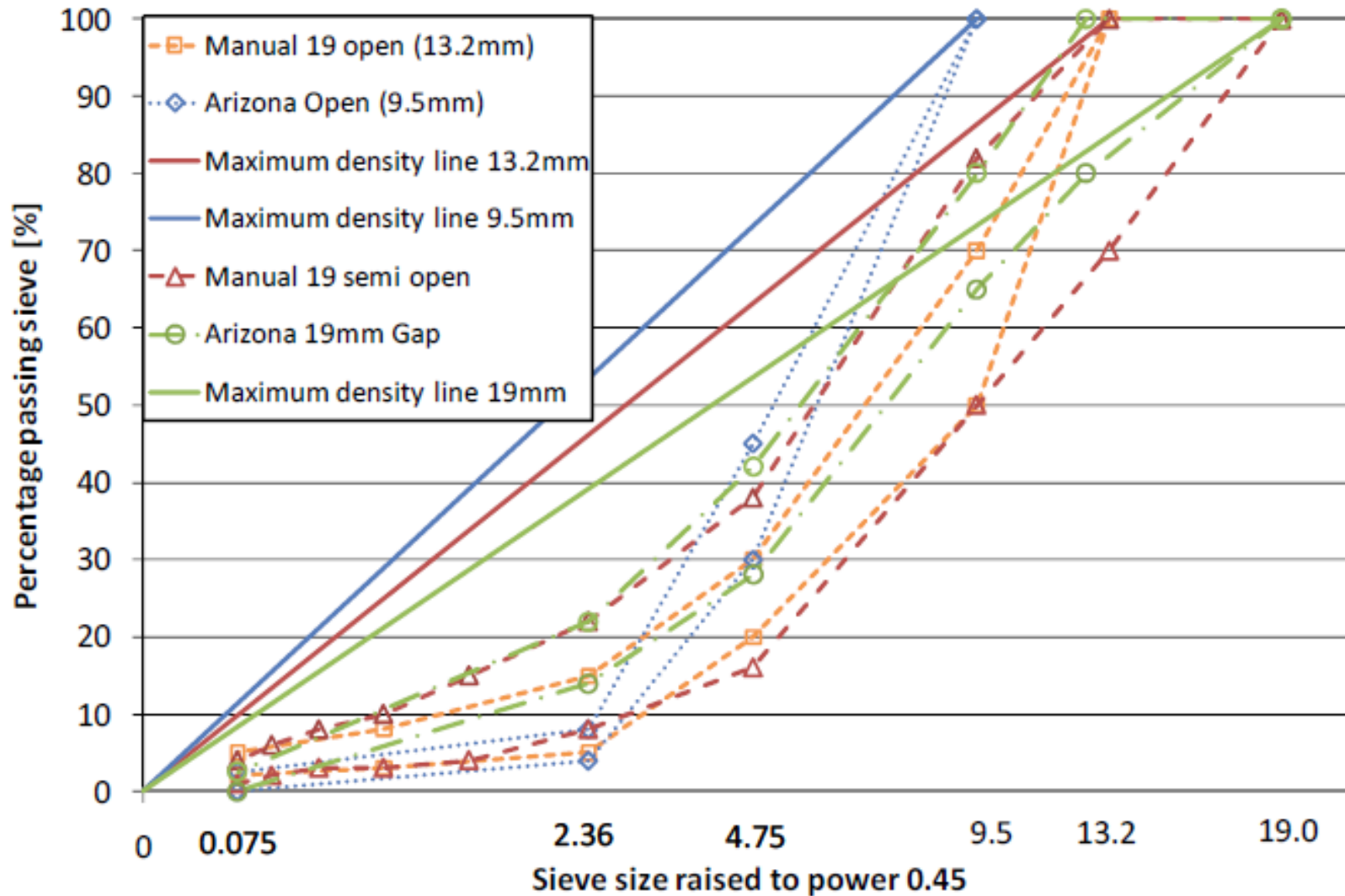
\* Measured after 45 minutes



# Desktop study: grading envelopes



# Desktop study: grading envelopes



# Mix Design

- Currently no clear direction in Manual 19 on determination of optimum binder content
- Marshall compaction @ 135°C typically used in RSA, too low for bitumen rubber mixes
- Currently no minimum requirement for VMA BRASO
- COLTO min. VMA of 17% for BRA may be too low
- SABITA Manual 17 – Design and Use of Porous Asphalt
- Modified Lottman criterion can be refined in line with Interim Guideline for the Design of HMA
- Tests currently included in design guide does not provide sufficient information on fatigue and permanent deformation performance

# Recommendations

# Recommendations

- Addressing GFIP Failures
  - Care should be taken not to crush the aggregate under the vibratory action on a concrete substrate
  - Include a minimum VMA requirement of 19% for BRASO
  - Narrow the aggregate grading envelope for BRASO, eliminating the overlap between BRASO and open graded mixes
  - Increase of the Marshall compaction temperature from 135 °C to 165 °C (Marshall design method for BR will in the medium term be replaced in its entirety by a performance based design method)

# Recommendations

- General Improvements to Manual 19
  - Reduce minimum natural rubber content requirement
  - Perform comparative testing to assess whether coarser crumbs reacted at lower temperatures lead to a more even viscosity-time curve
  - Include description of optimum binder content determination for continuously graded and semi-open graded mixes
  - Move towards the use of performance related design method for BR mixes (Ultimately Manual 19 should be completely incorporated in and replaced by the South African Asphalt Manual)

- 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

- General recommendations:
  - Further research into the use of terminal blends 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



**Thank you**