Development of a New Asphalt Mix Design Manual for South Africa

30th RPF 11 November 2015

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CSIR
Presented by Herman Marais
Much asphalt

SOCIETY FOR ASPHALT TECHNOLOGY

CENTRAL REGION
PRESENTS

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Workshop: "First CAPSA'15 Feedback Session – Asphalt Papers and Workshops"

The 11th Conference on Asphalt Pavements of Southern Africa which was held from 16 to 19 August 2015 was a huge success and was the biggest conference with more than 600 attendees. There were however young professionals that were not fortunate enough to attend the conference and this first CAPSA'15 Feedback Session is aimed at giving a condensed feedback of the highlights of the conference. This workshop would also benefit attendees that were not able to attend all the parallel workshops and presentations that were run concurrently. The first feedback session will cover asphalt related papers and workshops and the second feedback session will cover Bitumen and Sealwork.

DATE	11 November 2015
TIME	13h00 for 13h30
PLACE	CSIR International Convention Centre – Same venue as RPF

PROGRAMME

- 13h30-14h00 Welcome and Summary of Asphalt Papers ***(Herman Marais)***
- 14h00-14h40 Airport pavements Workshops feedback and Asphalt Failure Investigation Paper by ***(Emile Horak)***
- 14h40-15h10 EME implementation and RA research papers by ***(Sasheen Rajkumar)***
- 15h10-15h30 Comfort Break
- 15h30-16h00 Comparing current HMA Design Guideline with new Asphalt Design Manual ***(Elsabe van Aswegen)***
- 16h00-16h30 Use of WMA technologies in Long Haul Applications ***(Joanne Muller)***
- 16h30 Closure and Cocktails sponsored by ***Aveng***

Please pass this invitation on to any other interested colleagues, particularly Local Authorities, Metros, Developers and contractors who will undoubtedly gain knowledge from this valuable workshop.

Acknowledgements

- Project commissioned and funded by Sabita
- Project carried out by the CSIR
- 2 major asphalt manufactures in SA
- The industry experts
- Co-authors of paper
  - Johan O’Connell
  - Benôit Verhaeghe
  - Piet Myburgh

Initiation

- Need existed to update the South African mix design methods
  - SAPDM / SARDS
  - Transition to PG binder specification
  - Increasing use of unconventional mixes that require alternative design methods (WMA, EME, mixes w/ RA, industrial by-products, etc.)
  - Increased in volumes of heavy vehicles on SA roads
  - Demand for higher performance asphalt mixes
  - Review the current national compliance criteria for asphalt in contract specifications
  - International advances in asphalt mix design

Project framework

- Phase I: Establishing project management structure
- Phase II: State-of-the-art study
  - Evaluation of current mix design methods
  - Literature study to assess gaps
  - Consultation with industry experts
- Phase III: Experimental work and manual development

Objectives

- *Manual* will replace existing *guidelines* for the design of asphalt mixes in South Africa (Interim parallel testing on major projects)
- Move from *empirical*-based design towards *performance-related* design of asphalt
- Methods in line with international best practice
- Enable the formulation of national specifications

Increase reliability of asphalt mix design... simplify the design process …reduce the number of test methods involved

Scope / Features of the method

- Mix type selection
- Binder selection
- Aggregate section
- Mix design approach
- “Link” with pavement design
- Quality assurance

What is not covered “special mixes,” i.e. cold mixes, porous mixes, EMEs, …

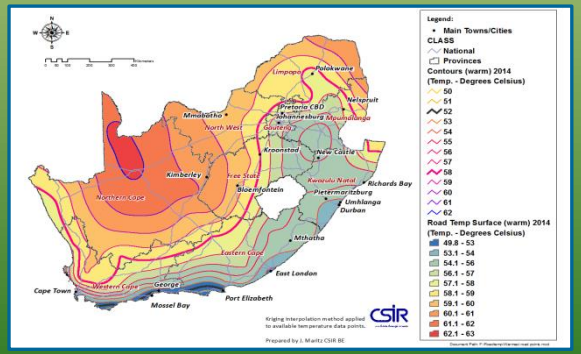
Mix type selection

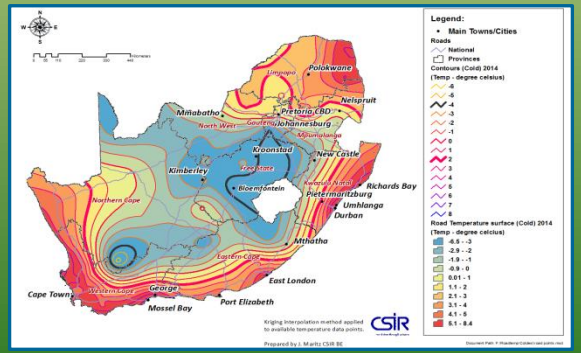
- Determining the aggregate packing characteristics of the mix is critical to mix type selection
- Mix types based on skeleton structure
  - Sand skeleton mixes
  - Stone skeleton mixes

Binder selection

- Performance grade (PG) binder selection methodology
  - Binder selection - based on environmental & traffic conditions
    - Two high temperature zones
    - A single low temperature
    - Traffic volume and speed

PG 58 - 22 ; PG 64 -16



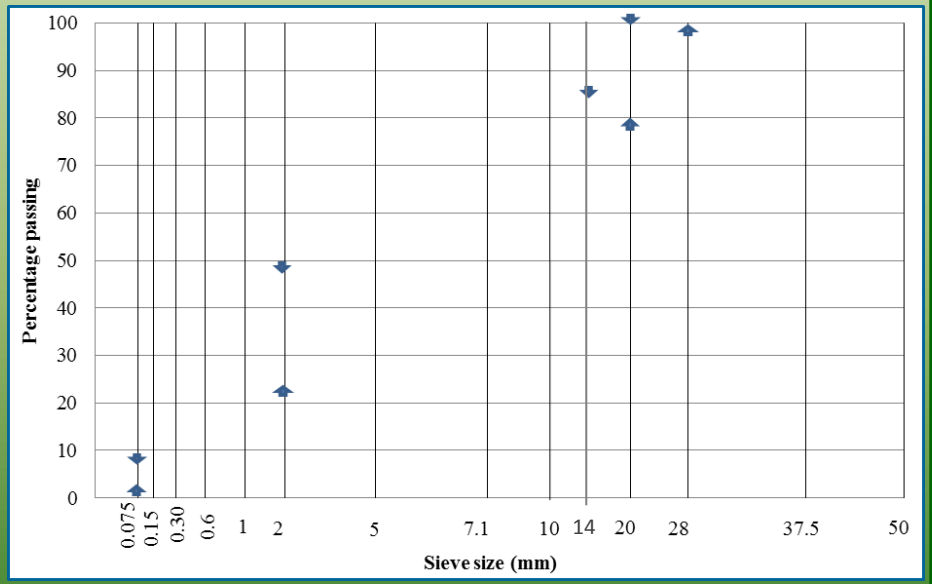


Traffic Volume (million ESAL)	Traffic Speed (Km/h)		
	< 20	20 - 70	> 70
< 10	H	S	S
10 – 30	V	H	H
> 30	E	V	V

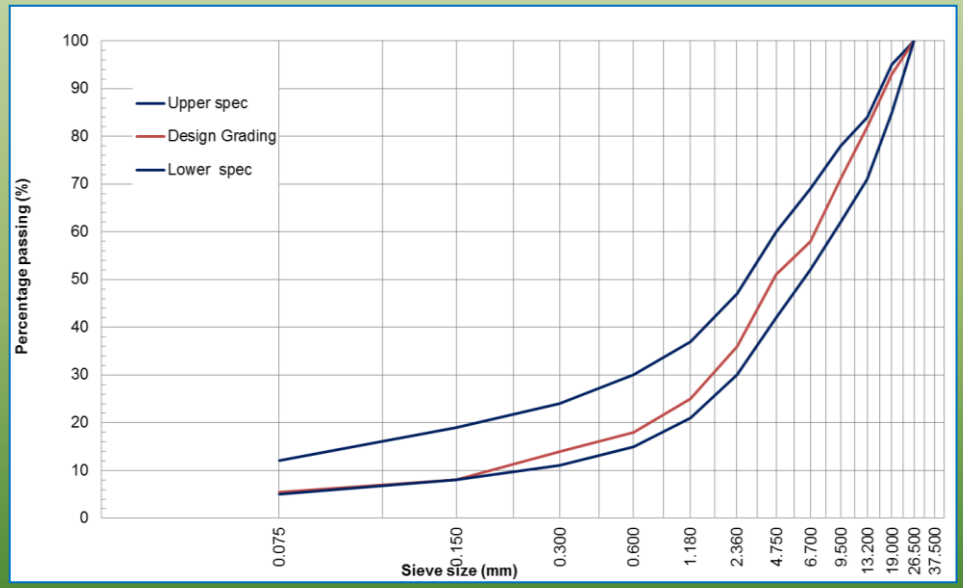
Aggregate selection

- General requirements and specifications for aggregates
- Grading of an aggregate blend should lie within certain key control points
- Existing grading bands are not a requirement
- Grading suited for quality control

Control points for grading selection



Grading control points for NMPS = 20 mm



Existing grading bands / limits

Mix design approach

- Three levels of designs are used in relation to traffic volume and risk profile
- Volumetric design approach is used to select optimum binder content for Level I
- Level I binder content serves as the starting point to select the optimum mix for design situations of Level II and Level III
  - Optimum binder content for Level II and Level III is selected based on performance tests

Minimum binder content

- Based on richness modulus - a measure of the binder film thickness surrounding the aggregate

$$B_{ppc} = K \times \alpha \times \sqrt[5]{SA}$$

B_{ppc} = mass of binder *expressed as a percentage of the total dry mass of aggregate, including filler*

$$B_{ppc} = \frac{100 \times P_B}{(100 + P_B)}$$

P_B = the binder content by mass of total mix

Mix design procedure - Level I

Level I : Low to medium volume roads

- **Low exposure to risk of structural damage (rutting, cracking)**
- **Up to 3 million E80s**
- **Volumetric design with mechanical properties testing**

- Preparation - Marshall or Gyratory
- Vol. design (4% voids criteria)
- Compliance with
  - Durability (TSR)
  - Stiffness – *ITS*
  - Permanent deformation – *dynamic creep modulus*
  - ~~Fatigue strength – *SCB*~~
  - Water permeability

Mix design procedure - Level II

Level II : Performance-related for medium to high volume roads

- **Medium to high exposure to risk of structural damage (moderate to severe rutting and cracking expected)**
- **3 to 30 million E80s**
- **Involves Level I volumetric design**
- **Performance tests to select optimum mix design**

- Preparation – Gyratory (increased no. of gyrations)
- Compliance with
  - Durability (TSR) (0.7 Base, 0.8 Surfacing)
  - AMPT dynamic modulus (stiffness) @ 20°C & 10Hz
  - HWTT @ 3 BCs (OBC based on lowest rutting)
  - 4PB Fatigue @ 10°C & 3 strain levels
  - Workability criteria (gyratory compaction)
  - Water permeability

Mix design procedure - Level III

Level III : Performance-related for very high volume roads

- **High exposure to risk of structural damage (rutting, cracking severe)**
- **≥ 30 million E80s**
- **Involves Level I volumetric design, full scale performance testing**
- **Performance data for advanced pavement design and analysis**

- As for Level II, but full scale Lab tests
  - Increased no of gyrations
  - Dynamic modulus test @ 6 frequencies, 5 temperatures
  - HWTT @ 3 BCs (OBC based on lowest rutting)
  - 4PB test @ 3 strain levels, 3 temperatures

Quality processes

Level I	Levels II, III
Contract based mix design • Aggregate properties, grading, binder content, VIM, MVD ,VMA, VFB, BD, ITS, dynamic creep, durability and permeability	**Certified mixes (or purpose designed mixes)** • Aggregate properties, grading, dynamic modulus, fatigue, permanent deformation, workability, durability, binder content, MVD and VIM
Plant mix and trial section • Binder content, grading, VIM, MVD, VMA, VFB, compaction density	**Trial section** • Grading, binder content and VIM/field density
Field/Site • Binder content, grading, VIM, compaction density, layer thickness • Frequency of sampling and acceptance limits are defined in the relevant specifications	**Field/Site** • Grading, binder content and VIM/ field density • Paving – QC: compaction, temperature control and limiting segregation

Lab testing & devp’t of criteria

- 13 SA asphalt mixes
- Extensive laboratory testing programme
  - Specialized testing (dynamic modulus, fatigue, permanent deformation)
- Criteria / interim criteria / typical values

Special mixes

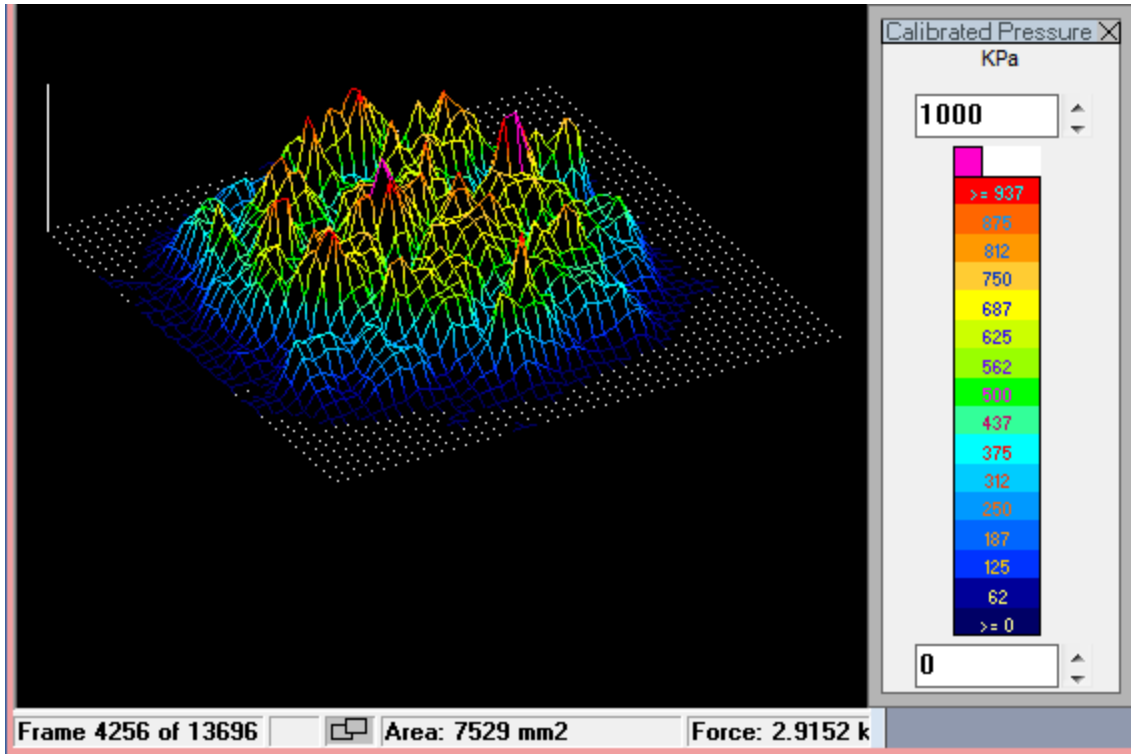
- Cold mixes – Sabita Man's 14, 21 and TG2
- Porous asphalt – Sabita Man 17
- Light traffic (residential areas) – Sabita Man 27
- WMA – Sabita Man 32
- EME – Sabita Man 33
- Mixes with RA – TRH 21
- SMA – Appendix of the design manual

On the road to implementation (Interactive process)

- Asphalt mix design workshop Midrand Feb 2012 – affirmed the proposed project
- Interaction with RPF (May 2013, May 2011)
- Sabita TDFP (industry, consultants, research, clients)
- Review by Sabita TDFP- 13 May 2014
- Industry workshop CSIR ICC18 November 2014
- Final review by Sabita TDFP
- Role out via SAT seminars

Conclusion

- We have come a long way with introducing performance related testing
- Urge Client bodies to start with parallel testing on major projects


Calibrated Pressure
KPa
1000
>= 937
875
812
750
687
625
562
500
437
375
312
250
187
125
62
>= 0
0
Frame 4256 of 13696
Area: 7529 mm2
Force: 2.9152 k