ASPHALT DESIGN METHOD FOR SA

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Initiation

- **Drivers**
  - SAPDM
  - Translation to PG binder specification
  - Limited validation of technology proposed in IGDHMA (2001)
  - Innovation in asphalt production (WMA, RA and EME)
  - International and local advances in technology.
  - The increased volumes of heavy vehicles on SA roads
- **Framework**
  - Developed in Dec 2009
  - Informed by SAPDM
  - Inform COTO specification
- **Research contract Sabita – CSIR 2010**
  - Essentially consisting of 3 phases

Project framework

- Phase I: Establishing project management structure
- Phase II: Evaluation of current 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
- Move from ***empirical***-based design towards ***performance related*** design of asphalt
- Methods in line with international best practice
- Enable the formulation of national specifications

Scope of method

- Mix type selection
- Binder selection
- Aggregate section
- Mix design procedure
- ***Link with pavement design***
- Quality assurance/control

Features of the method

- Mix type selection
- Mix design procedure
- Link with pavement design
- Quality assurance

Mix type selection

- Mix types based on skeleton structure
  - Stone skeleton
  - Sand skeleton
- Gradings a secondary property
  - Suited for quality control
  - No more generic types e.g. COLTO fine/coarse etc.
  - Suggested control points for sand skeleton mixes (most common)
    - MPS – layer thickness
    - 2mm & 75 μm sieves
- Bailey method recommended - optimise mix composition

Grading control points

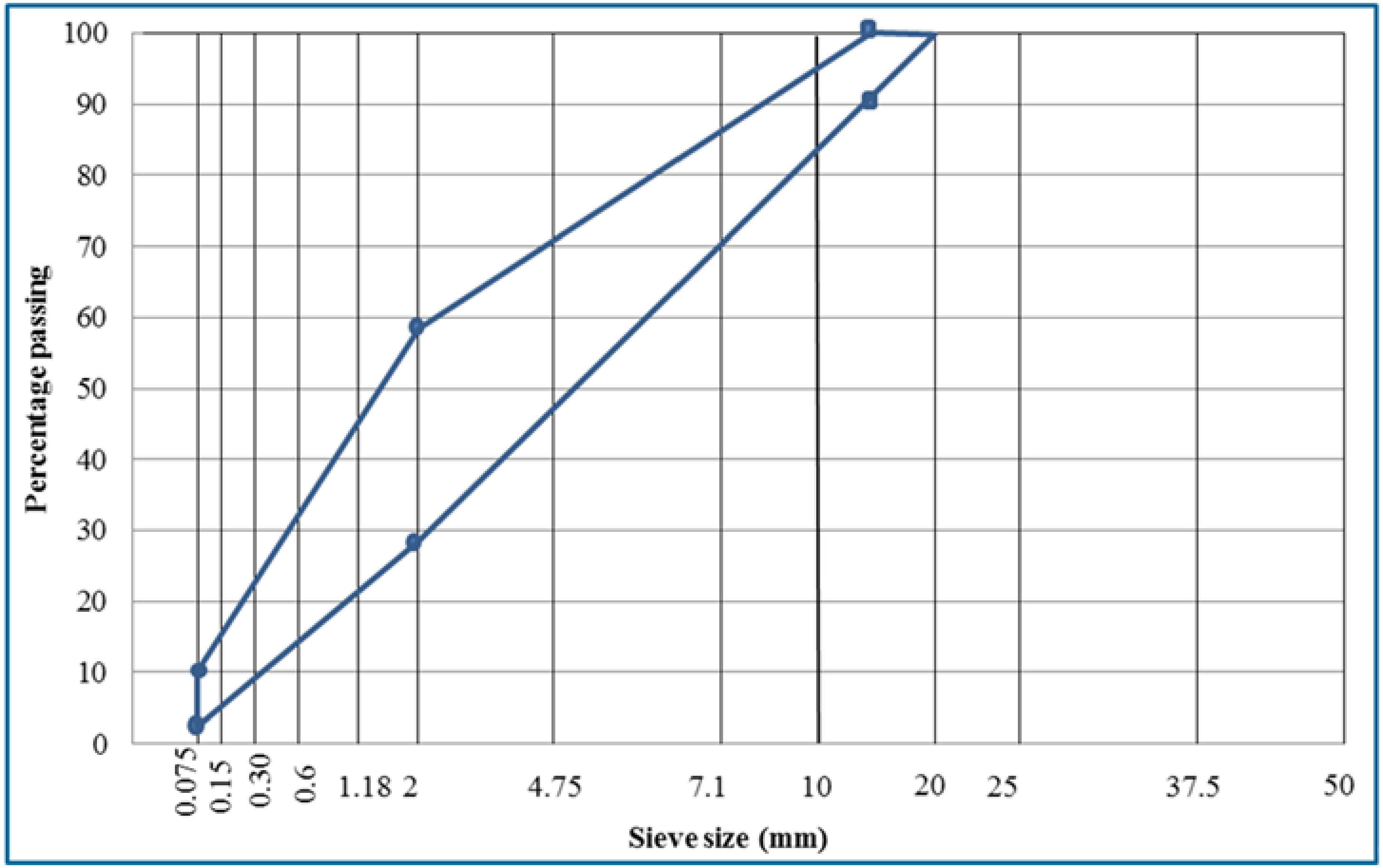
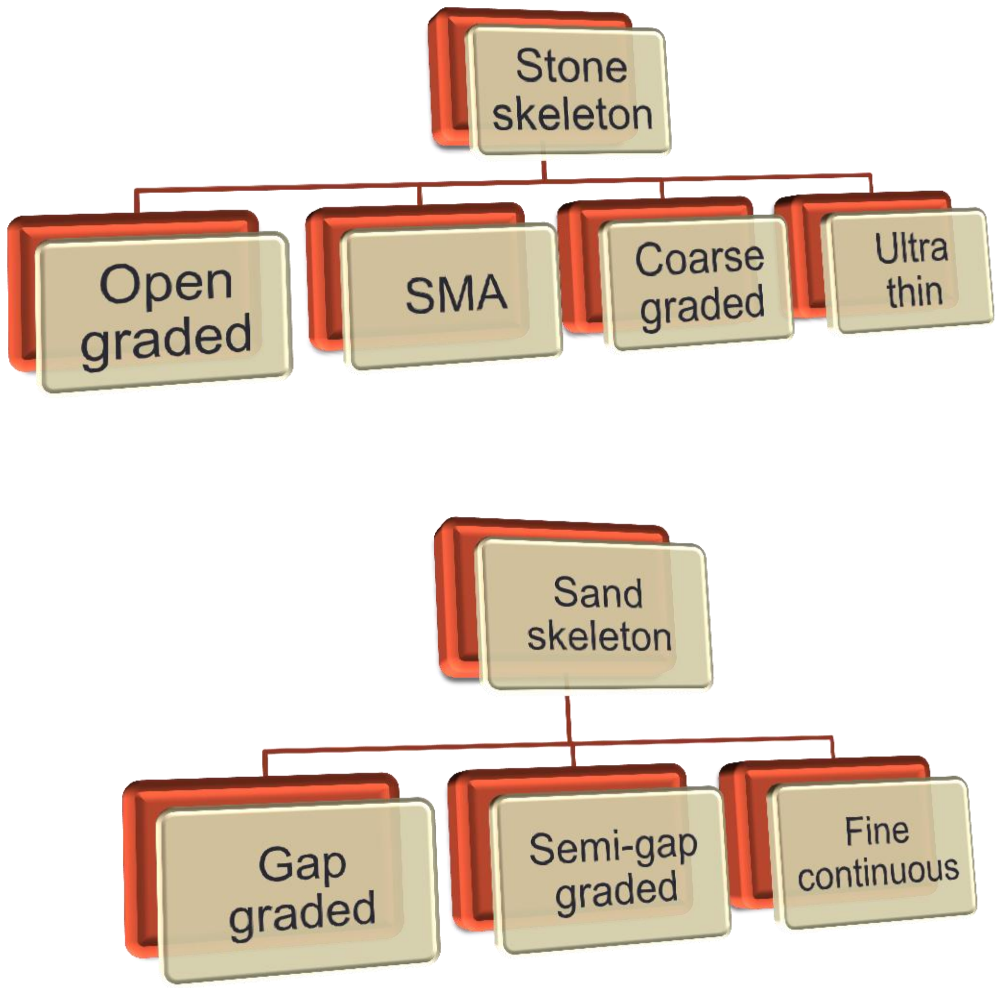


Figure 4.1: Grading control points plotted on 0.45 power chart for MPS = 14 mm

Classification of mix types



Mix design procedure

- Three design levels
  - Level I – ≤ 3 million ESALs
  - Level II – ≤ 30 million ESALs
  - Level III – > 30 million ESALs

Level I

- Either Marshall or Gyratory specimen preparation
- Mainly volumetric design
- Binder content expressed as a ***Richness Modulus***
- Compliance with performance related requirements
  - Durability – TSR (modified Lottman test)
  - Stiffness – ITS
  - Permanent deformation – dynamic creep modulus
  - Fatigue strength – SCB test – criteria to be developed
  - Permeability

(No Marshall Stability or Flow compliance requirements)

Level II

- Start with volumetrics as per Level I (gyratory)
- Compliance with performance criteria
  - Durability TSR (modified Lottman test)
  - Stiffness (dynamic modulus) AMPT
    - Frequency sweep (0,1, 0,5, 1, 5,10 & 25Hz at 20°C
  - Permanent deformational 3 binder contents
    - Flow number – deviator stress 483 kPa; confining 69 kPa
    - Optimum binder content – highest flow number
  - Fatigue
    - 4PBT – 10Hz at 10 °C & 3 strain levels – fatigue curve
    - fatigue life: 50% reduction in flexural stiffness
  - Workability criteria (gyratory compaction)
  - Permeability

Level III

- As for Level II, but full scale permanent deformation and fatigue tests
  - Dynamic modulus
    - 5 frequencies and 5 temps (-5, 5, 10, 20, 40 & 55 °C)
  - Permanent deformation at 3 binder contents
    - 3 Deviator stress levels with confining 69 kPa; 3 test temps
    - Record plastic strain at 20 000 cycles
    - Optimum binder content – highest flow number
  - Fatigue life
    - 4PBT - 10Hz at 5, 10 & 20 °C & 3 strain levels

Special mixes

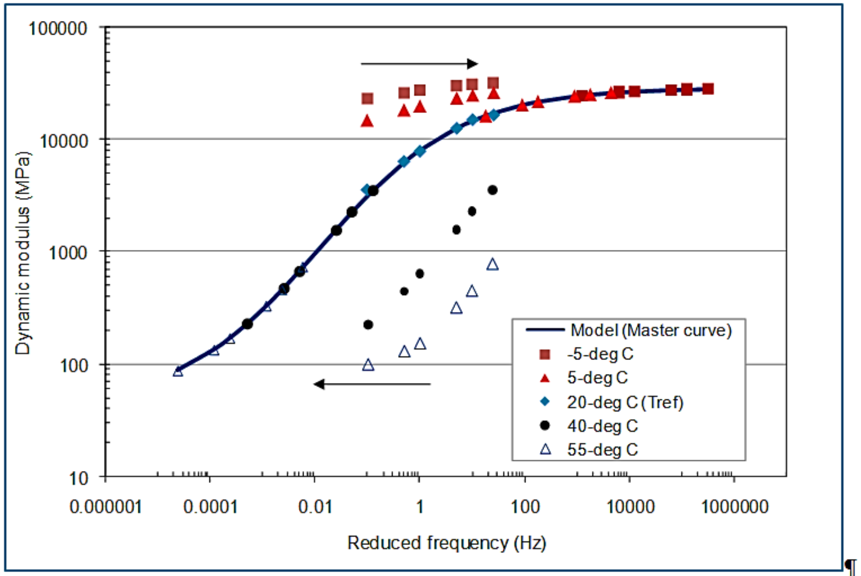
- Cold mixes – Sabita Man's 14, 21 and TG2
- Porous asphalt – Sabita Man 17
- Light traffic (residential areas) – Sabita Man 27
- WMA – Sabita Man 32
- EME – Sabita Man 33
- Mixes with RA – TRH 21
- SMA – Appendix of the design manual

Link with pavement design (under construction)

- SAPDM requires response & damage models
  - Dynamic modulus
    - Witczak prediction
    - Hirsch prediction
    - Laboratory tests
  - Asphalt damage models
    - Permanent deformation
    - Fatigue fracture

Dynamic Modulus

- Empirical models (Witczak, Hirsch)
  - Binder properties
  - Mix volumetrics
  - Gradings
  - Packing
- Laboratory method
  - Deriving master curve



Damage modelling

- Permanent deformation
  - Based on repeated load triaxial testing
  - Linkage to AMPT required
- Fatigue cracking
  - Based on 4PBT
- Temperature prediction
  - Max surface temperature
  - Min surface temperature
  - Temperature at depth

Quality assurance

- Principles
  - Level I
    - Mix design tendered for each application
    - Client approval
  - Levels II and III
    - Extensive performance testing
    - Impractical to repeat on contractual basis
    - Suppliers - develop certified mixes for a range of applications
    - If not certified, a similar approach would be followed

QA processes

Level I	Levels II, III
Contract based mix design • Aggregate properties, grading, binder content, VIM, MVD, VMA, VFB, BD, ITS, dynamic creep, durability, 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, binder stiffness and VIM/field density
↓	↓
Field/Site • Binder content, grading, VIM, compaction density, layer thickness • Frequency of sampling and acceptance limits as per the specifications	**Field/Site** • Grading, binder content, binder stiffness and VIM/ field density • Paving – QC: compaction, temperature control and limiting segregation

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 13 May 2014
- SAT will be requested to workshop the method
- Final review by Sabita TDFP
- Industry workshop

Notes

- Introduction of the PG specifications - requires changes
- Terms such as AE-1, AP-1 will ultimately go
- Expertise resides with producers who should produce (and certify) designs for a variety of applications
- COLTO type gradings are not a requirement