Introduction to Road Materials Engineering

Part 5: Introduction to Hot Mix Asphalt

Presented by SARF

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What *is* hot-mixed asphalt ?

Mixture of hot bitumen and crushed aggregate that is used in the road pavement as a base or surfacing.

Materials used in hot-mixed asphalt

Basic components:

- Stone – quality (strength, shape, grading, absorption, polishing)
- Sand – quality (grading, sand equivalent)
- Filler – choose inert or active filler
- Bitumen – pen grade

Other materials used in asphalt mixes if needed:

- Polymers – EVA (plastomer), SBS, RB (elastomer)
- Wax
- Gilsonite - resin
- Cellulose wood fibre

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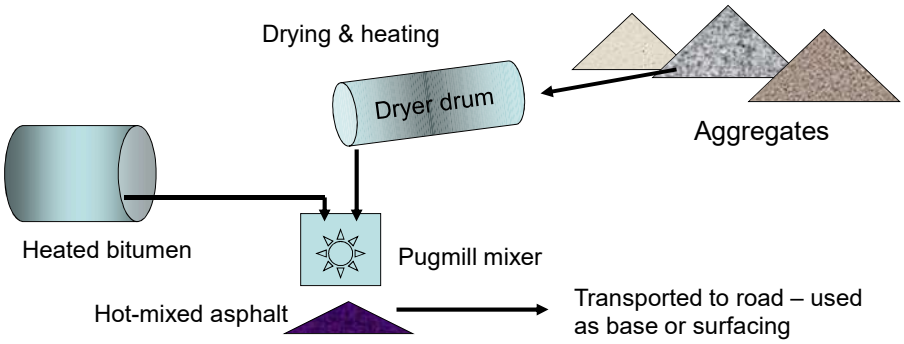
What *is* hot-mixed asphalt ?



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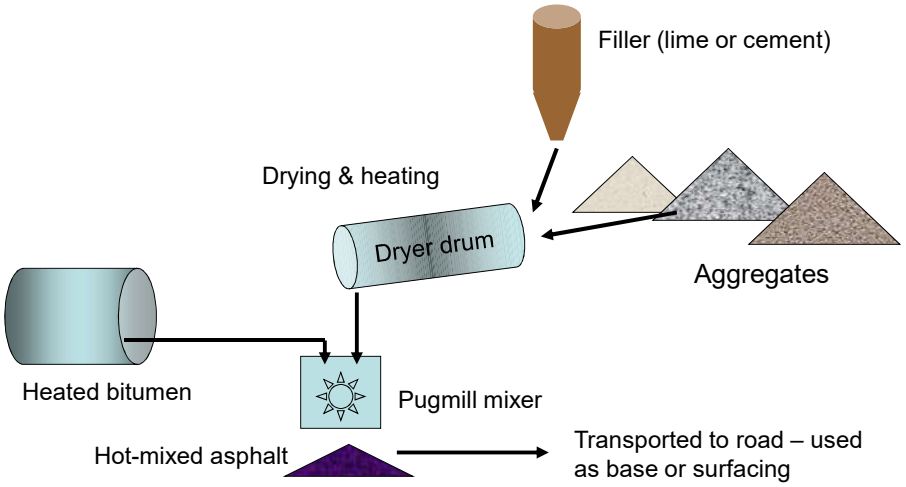
What *is* hot-mixed asphalt ?



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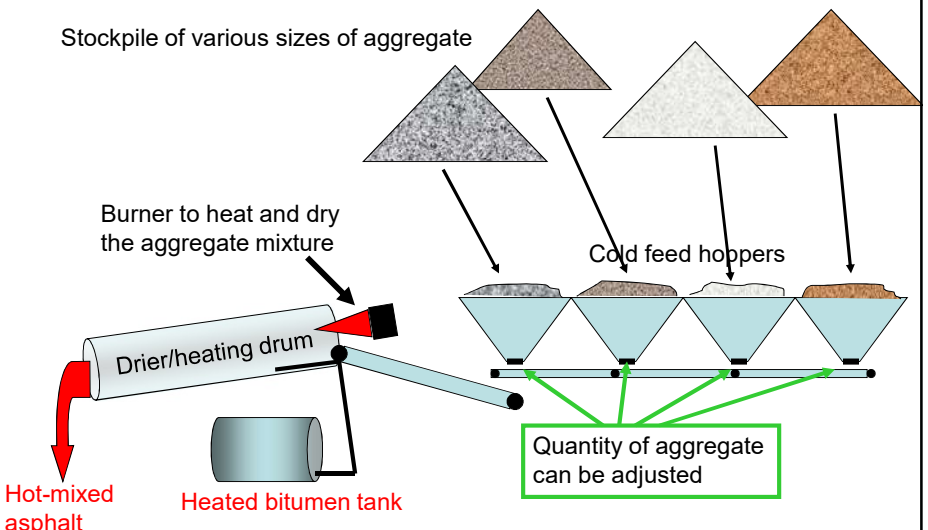

The delivery of aggregate from the cold feed bins must be calibrated to produce the required grading

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How asphalt is made

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Click Picture

Introduction to hot-mixed asphalt

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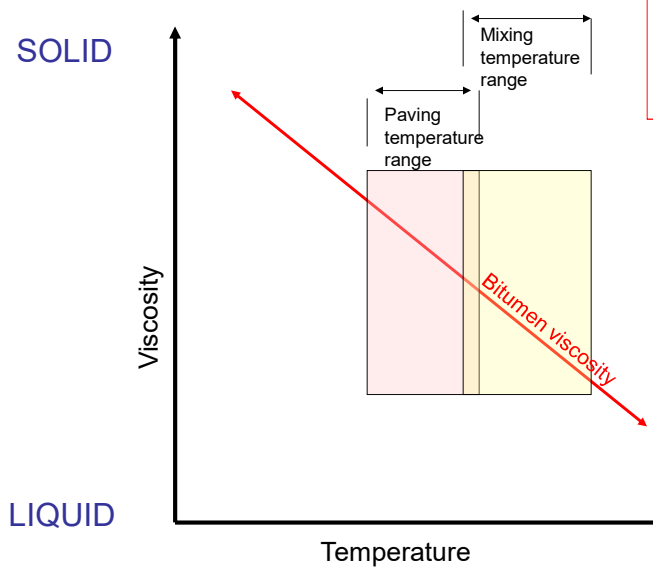
Mill and Overlay

Click Picture



Note

If bitumen is heated to too high a temperature it will degrade and its performance with be significantly reduced

Typical mixing temperatures for continuously graded mixes

35/50pen	140 to 165 °C
50/70pen	135 to 160 °C

Paving temperatures

Shall not be more than 10°C less than min mixing temperature

Summary of some important aspects of asphalt mixes

- Grading
- Bitumen content
- Void content
- Marshall Stability & Flow
- Compaction

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Basic asphalt design principles

The Marshall Mix Design Method

Main steps in the Marshall mix design procedure:

1. Combine the various aggregates and filler to make up the required grading
2. Heat the aggregate & filler mixture to the required mixing temperature. Heat the bitumen to the required mixing temperature
3. Mix the aggregates and bitumen together thoroughly, transfer to a Marshall mould and compact using 75 blows of the Marshall hammer on each face.
4. Subject the compacted Marshall briquette to the following tests:
   - bulk relative density
   - Marshall Stability & Flow
   - Maximum theoretical relative density

The Marshall mix design procedure is still widely used although there are moves to use other more sophisticated design methods

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Basic asphalt design principles

The Marshall Mix Design Method

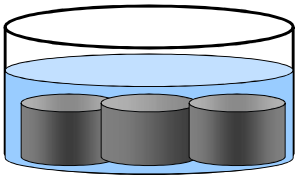
Marshall Hammer

BRD

Stability and Flow

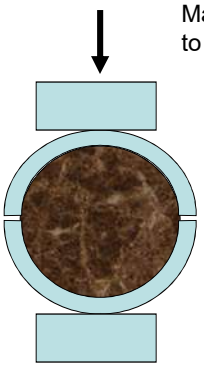
Bulk Theoretical Relative Density

Marshall Stability and Flow Test



Marshall briquettes are soaked in water for 30 minutes at 60°C

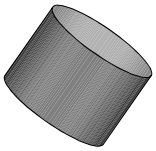
6 kN minimum



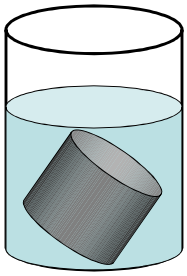
Marshall stability – max load to failure

Flow

Bulk Relative Density



Weight in air

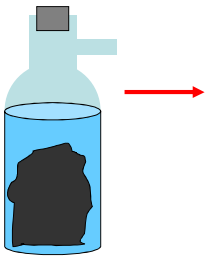


Weight in water

Bulk density = weight in air ÷ loss of weight in water

Max Theoretical Relative Density

Max theoretical relative density = weight of mix in air ÷ volume of voidless mix



Vacuum pump expels the air, filling the voids with water

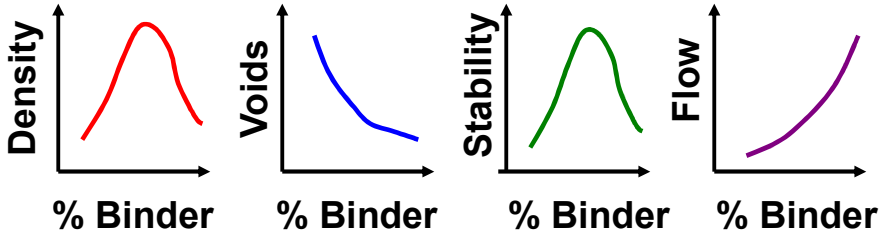
$$\text{Void Content} = 100 - \left(\frac{\text{BRD}}{\text{MTRD}} X\, 100\right)$$

The Marshall Mix Design Method

Marshall briquettes are prepared using the same aggregate mixture at 5 different bitumen contents.

The results of the tests are then plotted.

The optimum binder content is chosen, based on these results.



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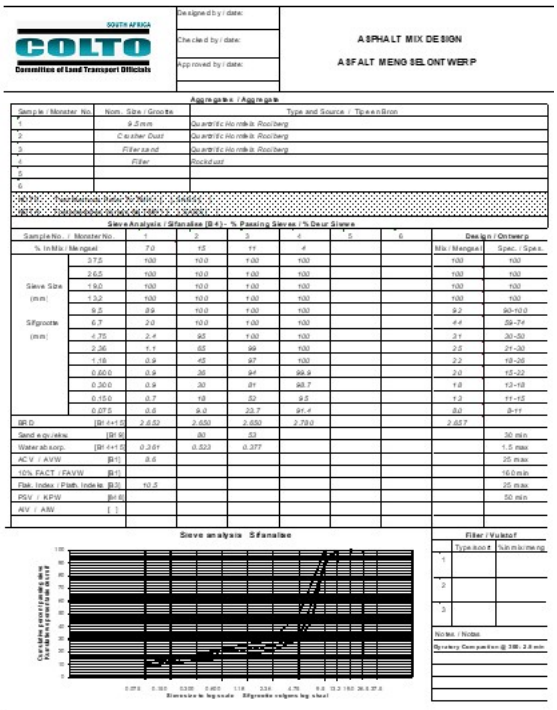

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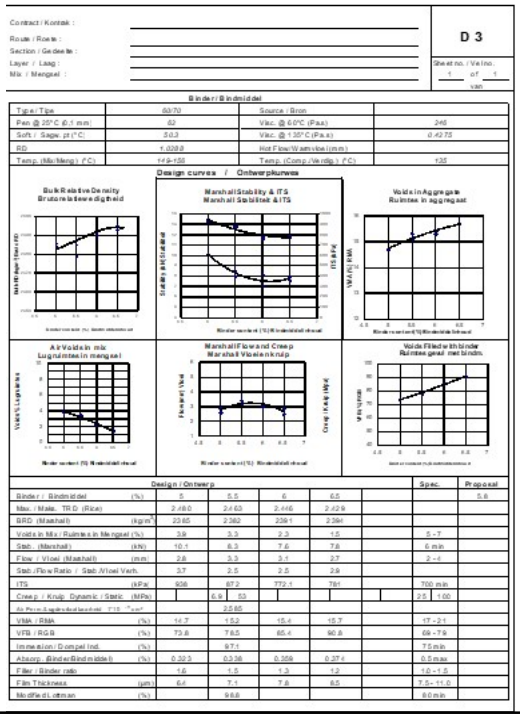

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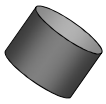
There are two ways of specifying compaction of hot-mixed asphalt:

- BRD of core sample as a percentage of Marshall density of the same mix



Usually specified as "The compaction of the asphalt shall not be less than 95% of Marshall density"

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There are two ways of specifying compaction of hot-mixed asphalt:

- BRD of core sample as a percentage of Maximum Theoretical Relative Density of the same sample

Usually specified as "The compaction of the asphalt shall not be less than 97% minus the design void content" - if design voids are 5% then min would be 92%

Most commonly used mix types

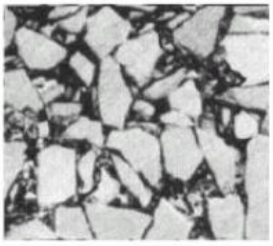
Continuously graded

Good distribution of the various particle sizes. Manufactured using ±3 aggregate fractions and crusher dust

Stone skeleton

Stone-on-stone contact. Voids between the larger aggregate pieces are filled with mastic

Known as SMA – stone mastic asphalt



Ultra thin friction course (UTFC)

- The UTFC is a stone skeleton type mix using modified binder
- An essential part of UTFC is a thick tack coat of modified bitumen emulsion. This provides good adhesion of the thin friction course to the underlying asphalt layer and provides a waterproofing membrane
- A specialised Spray-paver is used to pave UTFC – the tack spray system is incorporated into the paver

UTFC provides good skid resistance and riding quality, and has been found durable under heavy traffic

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