Module 5

Selection and application of bituminous binders

Recap on road binders

35/50, 50/70	MC 10	Stablemix	Stablemix	SBR	EVA
70/100, 150/200	MC 30		Premix	SBS	FT wax
PG 58 – 22	MC 3000		Spray	Rubber crumbs	Hydrocarbon
PG 64 – 18			Quickset		
PG 70 -10					

Applications – an overview

- Wearing courses
- Bases
- Prime coats
- Bond coats
- Curing membranes
- Precoating fluids

Wearing course

Wearing courses

- interface between the tyres and the main structural layers of the pavement.

They are required to be durable and provide:

- sufficient surface texture for skid resistance.
- a durable, waterproof, dust free all-weather surface;
- a waterproof cover for the substrate
- protection of the underlying layers against the scuffing effect of tyres causing material loss

Wearing course types

- Asphalt
- Spray seal
- Slurry
- Microsurfacing

Asphalt wearing courses

Two broad categories in terms of primary purpose:
  - Structural layers
  - Functional layers
- Structural layers
  - Generally thickness of ≥ 40 mm
  - contribute to the strength of the pavement
  - Surface texture for prevailing conditions
- Functional layers
  - Generally thickness of < 30 mm
  - Do not contribute significantly to pavement strength
  - Can be described as surface dressings

Bitumen for asphalt wearing courses

Product	Mixing Temperature °C	Compaction Temperature °C
50/70	150 -160	135 - 145
35/50	155 - 165	140 - 150
SBR modified	165 -175	150 - 160
SBS modified	160 - 170	140 - 150
EVA modified	160 - 170	140 - 150
FT wax modified	135 - 145	120 - 130
Bitumen rubber	170 - 210	150 - 165

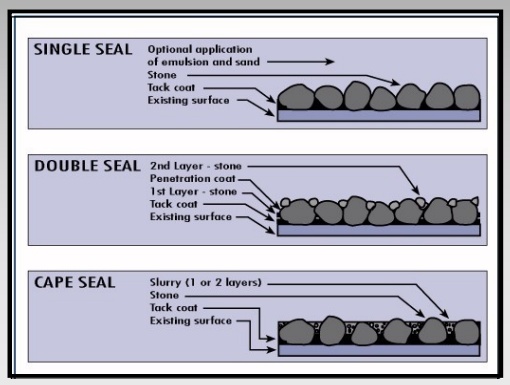
Note:
For thin asphalt wearing course (<30mm) carrying light traffic on streets in urban developments 70/100 pen grade bitumen is also used to facilitate compaction

Spray seals

Spray seals consist of ordered applications of one or more bituminous binders and stone chips

Popular in South Africa because of:

- cost-effectiveness
- versatility



Binder for spray seals

Product	Spraying Temperature °C	Typical Density at Spray Temperature	Minimum Road Temperature °C
70/100	170 – 180	0.93	25
150/200	155 – 165	0.93	21
MC 3000	130 – 145	0.93	15
SBR hot modified	190 – 200	0.92	25
SBS hot modified	180 – 190	0.92	25
SBR modified emulsion 65%	65	0.98	10
SBR modified emulsion 70%	70	0.98	10
Bitumen rubber	200 – 210	0.93	25
Cationic spray 60%	60	0.99	10
Cationic Spray 65%	65	0.98	10
Cationic Spray 70%	70	0.98	10

Slurries inc microsurfacing

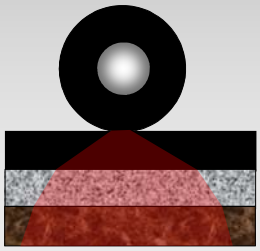
- A slurry is a homogeneous mixture of:
  - fine aggregate
  - stable-mix grade (or modified) emulsion
  - water
  - filler (lime or cement)
- Used for texturing and improvements to road finish
- Used as a filler (between stones in contact) in slurry bound macadam
- Microsurfacings are specially prepared slurries applied in thicker layers (say > 10mm) and use purpose made rapid setting emulsions

Applications – an overview

- Wearing courses
- Bases
- Prime coats
- Bond coats
- Curing membranes
- Precoating fluids

Base course

- Bases are designed to have adequate strength and distribute the traffic loads to lower layers
- Required properties:
  - Resistant to permanent deformation
  - Resistant to fracture (cracking)
  - Adequate stiffness (modulus)
  - Durable over their design life



Bituminous base types

- Asphalt bases
  - Used on heavily trafficked roads
  - Gradings selected to ensure proper packing and interlock of aggregates
  - High viscosity bitumen
- Bitumen stabilised bases
  - Relatively low bitumen concentrations
  - Designed for:
    - Enhanced strength
    - Stiffness
    - Resistance to effects of water

Bitumen for asphalt base

Product	Mixing Temperature °C	Compaction Temperature °C
50/70	150 -160	135 - 145
35/50	155 - 165	140 - 150
SBR modified	165 -175	150 - 160
SBS modified	160 -170	140 - 150
EVA modified	160 -170	140 - 150
FT wax modified	135 - 145	120 - 130
Bitumen rubber	170 -210	150 – 165

Bitumen stabilised materials

- Pavement materials treated with relatively low concentrations of bitumen (normally < 3% m/m)
- Bitumen introduced either as:
  - emulsion or
  - foamed bitumen.
- Prime purpose is to achieve
  - increase in material strength and stiffness
  - reduction in moisture susceptibility of the treated material
- In many cases active filler (cement or hydrated lime) is added to:
  - aid dispersion of the bitumen among the finer particles
  - in the case of bitumen emulsion, to control the break
- The cement content by mass should neither exceed 1%, nor the percentage of bitumen.

Binders for stabilisation

- Bitumen emulsion
- Foamed bitumen

Emulsions for stabilisation

- Cationic or anionic 60% stablemix used almost exclusively in SA
- Base bitumen usually 70/100 pen grade
- Stablemix grade enables
  - Mixing with dense graded materials
  - Extended workability periods for good dispersion

Compatibility of raw material types

- Selection of emulsion class influenced by the type of aggregate to be treated
- Certain aggregates are not suitable for use with anionic emulsions.

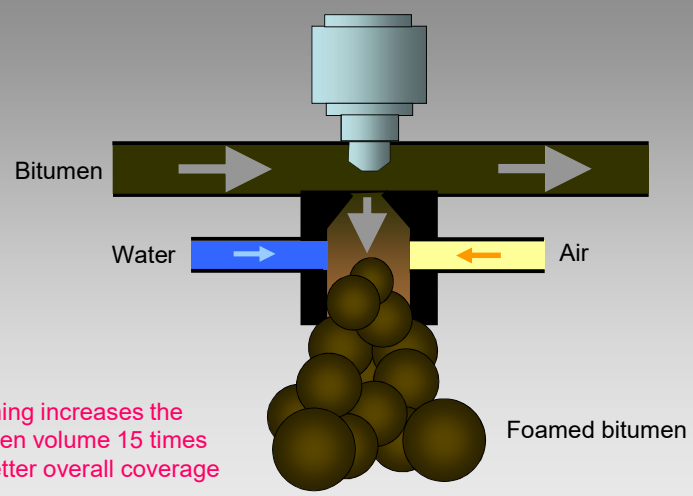
Aggregate Type	Compatible With	
	Anionic Emulsion	Cationic Emulsion
Dolerite	√	√
Quartzite	x	√
Hornfels/Greywacke	√	√
Dolomite	√	√
Granite	x	√
Andesite	√	√
Tillite	Variable	√
Basalt	√	√
Sandstone	x	√
Rhyolite	x	√
Marble/Norite	√	√
Syenite	x	√
Amphibolite	√	√
Felsite	x	√

NOTE: On bigger projects emulsion manufacturers may formulate "fit for purpose" emulsions, specifically for the materials encountered.

Foam stabilisation

- Produced by injecting water (and air sometimes) into hot bitumen in an expansion chamber
- Water is turned into vapour trapped in tiny bitumen bubbles
- Bitumen volume expands 15 times
- Foam dissipates within a minute
- Foaming process carried out on site
- Incorporated into aggregate while still in foam state
- Bitumen bubbles burst producing tiny bitumen particles that disperse by adhering to finer particles
- On compaction bitumen particles pressed against larger aggregates with “spot-welds”

Foamed bitumen



Foaming increases the bitumen volume 15 times for better overall coverage

Bitumen for foaming

- 70/100 pen grade generally selected for foam
- Softer and harder bitumen has been used successfully
- Harder bitumen generally avoided due to poor foam quality.
- Penetration value alone does not assure suitability
- Foaming properties of candidate bitumen grades need to be tested and assessed

Applications – an overview

- Wearing courses
- Bases
- Prime coats
- Bond coats
- Curing membranes
- Precoating fluids

Prime coats

An application of suitable bituminous binder to a non-bituminous (granular) layer prior to the application of a bituminous layer

Function:

- Provide adhesion between granular layer and bituminous layer
- Inhibit ingress of liquid water while not hampering the evaporation of water
- Limit absorption of binder application by base
- Bind finer particles of the base upper zone

Usually cutback bitumen or invert emulsion

Binders for priming

Product	Spraying Temperature °C	Typical Density at Spray Temperature	Minimum Road Temperature °C
MC 10	Ambient – *no heating required*		
MC 30	55	0.91	10
Invert emulsion	60	0.90	10

NB! HSE issue due to additional cutter in MC10

Applications – an overview

- Wearing courses
- Bases
- Prime coats
- Bond coats
- Curing membranes
- Precoating fluids

Bond coat

- Applied to primed or other bituminous surface to promote adhesion of between existing surface and asphalt layer (especially during construction)
- Usually bitumen emulsion applied immediately before placing asphalt layer
- Stablemix (anionic or cationic) most suitable as it can be diluted with water

Applications – an overview

- Wearing courses
- Bases
- Prime coats
- Bond coats
- Curing membranes
- Precoating fluids

Curing membranes

- Used to facilitate curing of cementitious layers (i.e. cement or lime stabilised)
- Low applications i.e. thin layer
- Anionic stablemix grade (to ensure continuity/uniformity)

Applications – an overview

- Wearing courses
- Bases
- Prime coats
- Bond coats
- Curing membranes
- Precoating fluids

Precoating fluids

Pre-coating of surfacing chips – common practice today

Cost-effective means of minimising risk of early chip loss due to poor adhesion

Not a substitute for accepting dirty/dusty aggregate or poor workmanship

Should not be substituted by adding cutter to the binder

Temperatures during handling and storage

- Prolonged heating will cause degradation of binder
- Maximum temperatures given should not be exceeded
- Modified hot binders circulated during heating – prevent localised over-heating
- Circulation of emulsion kept to a minimum to prevent shearing of bitumen globules

Handling temperatures

Binders for spray application

Product	Maximum Time at Spray Temperature Hours	Minimum Pumping Temperature °C
80/100	24	115
150/200	24	105
MC 3000	8	85
SBR hot modified	8	150
SBS hot modified	12	140
SBR modified emulsion 65%	8	15
SBR modified emulsion 70%	8	15
Bitumen rubber	6	150
Cationic spray 60%	24	5
Cationic Spray 65%	24	15
Cationic Spray 70%	24	15

Handling temperatures

Binders for asphalt

Product	Maximum storage temperature < 24 hours °C	Maximum storage temperature > 24 hours °C	Minimum Pumping Temperature °C
60/70	160	140	120
40/50	165	140	125
SBR modified	180	140	140
SBS modified	180	140	140
EVA modified	170	140	140
FT wax modified	150	120	120
Natural hydrocarbon modified	175	140	130
Bitumen rubber	165	140	160

Module 5 - Summary

- Binder selection should be optimised for the various applications
- Prolonged heating will cause degradation of binder - recommended maximum temperatures and durations given should be observed

Barry Pearce - LMetc
barry@learningmattersetc.co.za
082 883 2225