**Bitumen & Binders**

**AAPA training**

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**Bitumen – What is it?**

A complex hydrocarbon produced from oil

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**Bitumen – How is it produced?**

- Atmospheric Distillation at 300–350°C
- Vacuum distillation producing bitumen and/or short residue.
  - Short residue air-blown or mixed with harder/softer grades to make bitumen

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**Bitumen – How does it behave?**

- Stiffness is time and temperature dependent
  - Stiff at:
    - High loading rates
    - Low temperature
  - Soft at:
    - Slow loading rates
    - High temperatures

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**Bitumen – How does it behave?**

- Thermoplastic
  - Inert solid at low temperatures > 25°C
  - Liquid at temperatures +100°C

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**Bitumen – Why we use it?**

- Waterproofing
- Adhesive
  - The glue in asphalt and sprayed seals
Bitumen – where we use it

- Roofing
- Paints
- Electrical insulation
- Paving
  - Asphalt
  - Spray sealing

Estimated 800k tonnes annual bitumen usage

NSW 185Kt - QLD 320Kt - VIC 160Kt - SA 55Kt - WA 60Kt - NT 5Kt - TAS 15Kt

Multi-grade Bitumens

Produced as a result of a change to the manufacturing process resulting in:

- Reduced temperature susceptibility
- Increased rut resistance
- Superior adhesion
- Improved fatigue performance
Cutback Bitumen

- **Bitumen + cutter**
  - Kerosene, flash point of 40 - 45°C
  - High Flash Cutter, flash point of 60 - 65°C
- **Manufacture of**
  - Primes (45 – 55% cutter)
  - Primerbinders (10 – 20% cutter)
  - Cold mixes

Cutback Bitumen

Temporarily reduce the viscosity allowing more time to apply aggregate.

**Quantity of cutter depends on:**
- Ambient air temperature
- Traffic volume
- Type and size of aggregate used.

Can reduce risk of aggregate loss in cooler weather.

Polymer Modified Binders

- **Bitumen (C170 or C320) + Polymer**
- **Elastomers**
  - STYRENE-BUTADIENE-STYRENE (SBS)
  - POLYBUTADIENE (PBD)
  - CRUMB RUBBER
- **Plastomers**
  - ETHYLENE VINYL ACETATE (EVA)

Polymer Modified Binders

Improved performance and longer life

- Flexibility
- Adhesion
- Cohesion
- Stiffness

Polymer Modified Binders

Austroads PMB Specification

Specification Framework for Polymer Modified Binders and Multigrade Bitumens (AGPT/T190)


Spray Sealing Grades

<table>
<thead>
<tr>
<th>Method</th>
<th>Binder Type</th>
<th>Temperature (°C)</th>
<th>S1</th>
<th>S15</th>
<th>S20</th>
<th>S25</th>
<th>S35</th>
<th>S40</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGPT/T12</td>
<td>Sealing</td>
<td>-25</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>AGPT/T13</td>
<td>Sealing</td>
<td>-30</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>AGPT/T14</td>
<td>Sealing</td>
<td>-35</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

S - Sealing Binder E - Elastomer R - Crumb Rubber
Field Produced Crumb Rubber

Table 3.4: Properties of Field Produced Crumb Rubber Binders

<table>
<thead>
<tr>
<th>Property</th>
<th>Method</th>
<th>S1RF (%)</th>
<th>S1RF (%)</th>
<th>A2RF (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal rubber concentration (%)</td>
<td>A2RF (%)</td>
<td>15</td>
<td>15</td>
<td>25 – 30</td>
</tr>
<tr>
<td>Rubber content by analysis (%) (%)</td>
<td>ASPT12 (%)</td>
<td>weekly</td>
<td>weekly</td>
<td>weekly</td>
</tr>
<tr>
<td>Softening point (°C) (%)</td>
<td>ASPT10 (%)</td>
<td>55</td>
<td>62</td>
<td></td>
</tr>
<tr>
<td>Consistency at 60°C</td>
<td>ASPT11 (%)</td>
<td>weekly</td>
<td>report</td>
<td>report</td>
</tr>
<tr>
<td>Thermal recovery (%) (%)</td>
<td>ASPT10 (%)</td>
<td>weekly</td>
<td>25</td>
<td>30</td>
</tr>
</tbody>
</table>

S1RF
- Sealing Binder
- 15 - % Rubber
RF – Rubber Field Blended

Asphalt Grades

A - Asphalt Binder
E – Elastomer
P - Plastomer

Torsional Recovery Test

Bituminous Binder Selection

- Sprayed Sealing
  - Bitumen
  - Bitumen Emulsions
  - Polymer Modified Binders

- Asphalt
  - Bitumen
  - Bitumen Emulsions
  - Polymer Modified Binders

- Maintenance
  - Cutback (crack filling)
  - Bitumen Emulsions (patching)

Binder Selection - Sprayed Sealing

Selection of the binder includes assessment of

1. Nature of treatment
2. Pavement Condition
3. Aggregate properties
4. Environmental factors

Cutback Primes & Primerbinders

Used for new works – granular, timber, concrete

Grades produced fall into three main categories:
- Australian Standard 2157 Grades
- Proprietary Grades
- Field Produced Grades

Always prime or primerseal a new surface
Cutback Primers

Selection based on:
- Surface finish
- Material type
- Density

Aim for:
- Absorption
- Matte dark brown

At least 72 hours to cure

Cutback Primerbinders

- Primerbinders used in temporary seals where there were difficulties using primers
  - Building road under traffic
  - Cant wait for prime to cure
  - Cold and damp weather conditions.

- Cutback primerbinders 3 – 6 months to cure.

Cutback Primes & Primerbinders

<table>
<thead>
<tr>
<th>Generic Grade</th>
<th>AS 2157 Grade</th>
<th>Viscosity Range (Pa.s @ 60°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prime Light</td>
<td>AMC 00</td>
<td>0.008 – 0.016</td>
</tr>
<tr>
<td>Medium Heavy</td>
<td>AMC 0</td>
<td>0.025 – 0.050</td>
</tr>
<tr>
<td>Heavy AMC</td>
<td>1</td>
<td>0.080 – 0.120</td>
</tr>
<tr>
<td>Primerbinder</td>
<td>Medium AMC</td>
<td>4</td>
</tr>
<tr>
<td>Medium Heavy</td>
<td>AMC 5</td>
<td>5.5 – 11.0</td>
</tr>
</tbody>
</table>

Unmodified Binders- Sprayed Sealing

The most common bitumen used in spray sealing is Class 170.
- Relatively straight roads
- Low stress environments
- Low to medium traffic levels
- No or isolated minor cracking

Polymer Modified Binders for Spray Sealing

Most common application areas are:
- HSS (high stress seals)
- XSS (extreme stress seals)

<table>
<thead>
<tr>
<th>SAM (strain alleviating membranes)</th>
<th>SAMI (strain alleviating membrane interlayers)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improving aggregate retention;</td>
<td>Minimising or delaying reflective cracking;</td>
</tr>
<tr>
<td>Improving shear resistance;</td>
<td>Improving water-proofing.</td>
</tr>
<tr>
<td>Minimising bleeding;</td>
<td></td>
</tr>
</tbody>
</table>

Binder Selection - Asphalt

The major purposes of binder in asphalt are:
- Glue the aggregate particles together
- Provide pavement flexibility
- Provide design waterproofing qualities

These features can be easily compromised if the bitumen or aggregate is excessively hot during the production of hot mix asphalt.

The temperature of the mix will help to determine how easily the mix will be spread and compacted.
Binder Selection - Asphalt

- Stiffness of the binder is a major contributor to the stiffness of the asphalt.
- Must determine its optimum content in the asphalt mix.
- Part of the mix design, required aggregate grading and binder content are determined.

Polymer Modified Bitumen and Multigrade

PMBs in asphalt can provide:
- improved crack control;
- rutting and shoving resistance;
- fatigue resistance;
- aggregate retention;
- resistance to high traffic stresses.

Multigrade in asphalt can provide
- rutting and shoving resistance;

Polymer Modified Bitumen for Asphalt

PMBs and Multigrade are used to enhance performance properties of mainly surface courses.

Overall asphalt performance is affected by the properties of the total mix, not by any one component.

Using a PMB will NOT overcome the deficiencies of poor pavement or mix design or the use of sub standard aggregate or filler.

Importance of binders

Deformation (mm), 55°C

![Graph showing deformation over load repetitions for different binders.](image)
Crack & Joint Filling

- Pavement cracking allows a path for the entry of moisture.
- Treatment will stop or slow down the rate of deterioration and improve the effectiveness of subsequent surfacing treatments.

Crack & Joint Filling

Pavement cracking can be broadly separated into two major types;
- Traffic induced by vehicles passing over the pavement;
- Environment induced due to temperature variations of the pavement or moisture variations in the sub base material.

Binder Selection - Crack & Joint Filling

Emulsions
- CRS type used.
- Can be applied in damp conditions
- Small cracks less than 2mm wide
- Grit off to prevent pick up

Binder Selection - Crack & Joint Filling

Hot applied PMBs
- Proprietary products
- Used in over-banding or routing and filling treatments.
- Suitable for cracks, about 5 - 15mm
- Cracks visibly moving (0.5 – 1mm of movement), may need to use in conjunction with a geotextile