Sprayed Seal Design

AAPA training

Design of Rates of Application

- Primes
- Primerseals
- Seals
  - C170 binder
  - Polymer modified binder
  - Geotextile reinforced seals (GRS)
- Surface enrichment

Priming

- Design of Rates of Application based on experience with type of pavement and primer.
- No formal design method

Rate of Set-Up for cutback primes:
- Hot weather – 6 to 12 hrs
- Cool Weather – 12 to 24 hrs
- Cold or cool and damp – 24 to 48 hrs

Time before applying next treatment
- Cutback prime - 3 days (minimum)
- Emulsion prime - 12 to 24 hrs

Guide to Rates of Application of Primer

<table>
<thead>
<tr>
<th>Primer</th>
<th>Pavement</th>
<th>Grade</th>
<th>Rate (L/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tightly bonded</td>
<td>Light</td>
<td>0.6 – 1.1</td>
<td></td>
</tr>
<tr>
<td>Medium porosity</td>
<td>Medium</td>
<td>0.8 – 1.1</td>
<td></td>
</tr>
<tr>
<td>Porous</td>
<td>Heavy to v. heavy</td>
<td>0.9 – 1.3</td>
<td></td>
</tr>
<tr>
<td>Limestone</td>
<td>Heavy to v. heavy</td>
<td>0.7 – 0.9/0.5 – 0.7</td>
<td></td>
</tr>
<tr>
<td>Sandstone</td>
<td>Medium to heavy Light</td>
<td>0.7 – 0.9/0.5 – 0.7</td>
<td></td>
</tr>
<tr>
<td>Hill gravel, sand</td>
<td>Stabilised</td>
<td>0.8 – 1.1</td>
<td></td>
</tr>
<tr>
<td>Concrete</td>
<td>Very light to light Light</td>
<td>0.5 – 0.8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Very light</td>
<td>0.2 – 0.4</td>
<td></td>
</tr>
</tbody>
</table>
Priming – small scale trial

- Apply measured quantity by hand (say 1L)
- Distribute evenly with brush
- Observe performance
- Decide on grade and rate

Primersaling

Primerbinder - Rates of Application

- No formal design procedure
- AUSTROADS design based on:
  - Traffic ranges (v/l/d)
  - Nominal aggregate size
  - Type of primer binder
  - Pavement condition
  - Local experience

Primersaling

Primerbinder – Rates of Application

- Determine base rates from AP-T68
- Add allowances for:
  - Pavement texture
  - Possible absorption
  - Possible aggregate embedment based on ball embedment test
- Total allowances:
  - generally averages +0.2 to +0.3 L/m²

Primersaling

Typical Aggregate Spread Rates

<table>
<thead>
<tr>
<th>Size of aggregate mm</th>
<th>Aggregate spread rate m²/m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand, size 5, size 7</td>
<td>130 – 150</td>
</tr>
<tr>
<td>Size 10</td>
<td>110 – 120</td>
</tr>
</tbody>
</table>
Design Philosophy

Basis for method:
- Use of one-sized aggregate
- Binder should be 50 to 60% up the height of the aggregate
- Aggregate particles may embed into base
- Binder may be absorbed into base
- Reseals interlock into the substrate

Design Philosophy

Maximum binder level (60%)

Reseals interlock into the substrate

Minimum binder level to provide adhesion of aggregate to base (50%)

AP-T68/06 Design

- Sprayed seals are a system
  - Binder and aggregate spread rate are both important
- Binder design rate of application for
  - S/S
  - Unmodified, modified, emulsion binders
  - Geotextile and Fibre Reinforced Seal

Design Input Data - Traffic

- Annual Average Daily Traffic
  - Representative
  - Current
- AADT is over all lanes
- Design traffic
  - Vehicles in each lane

Step 1 - Collect input data
Aggregate
- Grading (one sized)
- Flakiness Index (FI)
- ALD (A)
Design Traffic
- Vehicles/lane/day calculated from AADT
- Commercial vehicles
Road geometry
- Climbing/channelised lanes
Surface effects
- Texture (sand patch)
- Aggregate embedment (new work)
- Pavement absorption (not applicable if correctly primed)
Step 2 – Determine basic voids factor \( V_f \)
Charts using design traffic
- Two charts for different traffic ranges
- Use target line

Basic Voids Factor (\( V_f \)) – Traffic Volume
\( 0 – 500 \) vehicles/lane/day

Step 3 – Determine adjustments \( V_a \) & \( V_t \)
Aggregate shape \( V_a \)
- Table 2.1
- Flakiness index
Traffic \( V_t \)
- Table 2.2
- Heavy vehicles
- Climbing lanes
- Channelised lanes

Table 2.1: Adjustment to Basic Voids Factor for Aggregate Shape (\( V_a \))

<table>
<thead>
<tr>
<th>Aggregate type</th>
<th>Aggregate shape</th>
<th>Flakiness index (%)</th>
<th>Shape adjustment ( V_a ) ((\text{L/m}^2/\text{mm}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crushed or partly crushed</td>
<td>Very Flaky</td>
<td>&gt; 35</td>
<td>Not recommended for sealing</td>
</tr>
<tr>
<td>Fiaky</td>
<td>26 to 35</td>
<td>0 to + 0.01</td>
<td></td>
</tr>
<tr>
<td>Angular</td>
<td>15 to 25</td>
<td>Nil</td>
<td></td>
</tr>
<tr>
<td>Cubic</td>
<td>&lt; 15</td>
<td>+ 0.01</td>
<td></td>
</tr>
<tr>
<td>Rounded</td>
<td>NA</td>
<td>0 to + 0.01</td>
<td></td>
</tr>
</tbody>
</table>

Table 2.2: Adjustment to Basic Voids Factor for Traffic Effects (\( V_t \))

<table>
<thead>
<tr>
<th>Traffic</th>
<th>Adjustment to Basic Voids Factor ((\text{L/m}^2/\text{mm}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flat or downhill</td>
<td>Slow moving – climbing lanes</td>
</tr>
<tr>
<td>Normal</td>
<td>Channelised*</td>
</tr>
<tr>
<td>Normal</td>
<td>Channelised*</td>
</tr>
<tr>
<td>On overtaking lanes of multi-lane rural roads where traffic is mainly cars with ≤10% of HV</td>
<td>+0.01</td>
</tr>
<tr>
<td>Non-trafficked areas such as shoulders, medians, parking areas</td>
<td>+0.02</td>
</tr>
<tr>
<td>0 to 15% Equivalent Heavy vehicles (EHV)</td>
<td>Nil</td>
</tr>
<tr>
<td>16 to 20% Equivalent Heavy vehicles (EHV)</td>
<td>-0.01</td>
</tr>
<tr>
<td>21 to 40% Equivalent Heavy vehicles (EHV)</td>
<td>-0.02</td>
</tr>
<tr>
<td>&gt; 40% Equivalent Heavy vehicles (EHV)</td>
<td>-0.03</td>
</tr>
</tbody>
</table>
Step 4 – Determine design voids factor \( VF \)
\[
VF = Vf + Va + Vt
\]
\( % \) of \( VF \) outside of upper & lower limits?

Step 5 – Basic binder application rate \( Bb \)
\[
Bb (L/m²) = VF \times ALD
\]

Design Input Data - Aggregate

• Average Least Dimension
  – May use typical values for initial design

<table>
<thead>
<tr>
<th>Size</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>7mm</td>
<td>3.5 – 4.5 mm</td>
</tr>
<tr>
<td>10mm</td>
<td>5.0 – 6.0 mm</td>
</tr>
<tr>
<td>14mm</td>
<td>7.5 – 9.0 mm</td>
</tr>
<tr>
<td>20mm</td>
<td>10.5 – 12.0 mm</td>
</tr>
</tbody>
</table>

• Need values for lot to be used for final design

Polymer Modified Binder & Emulsion Seals

Step 5 – Modified Basic binder application rate \( Bbm \)
\[
Bbm (L/m²) = VF \times ALD \times PF
\]

• Apply a Polymer Factor (PF) varies with PMB & type of seal
• Add normal allowances
• Aggregate design spread rate:
  – 10% heavier than normal
• Emulsion seals – replace PF with EF
Step 6 – Design binder application rate \( B_d \)

\[ B_d = B_b + A_s + A_e \]

- Round to nearest 0.1 L/m²

### Allowances (L/m²)

- **As** - Surface texture
  - Sand patch texture depth (mm)
- **Ae** - Aggregate embedment
  - Ball penetration test
  - Negative allowance
- Absorption of binder by:
  - pavement
  - aggregate (not common)

Allowances are cumulative

_________

Sand patch test – 50cc spread uniformly to calculate texture in mm – determine As allowance from Table

### Allowances (L/m²)

- **As** - Surface texture
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Allowances are cumulative
Allowances (L/m²)
• As - Surface texture
  – Sand patch texture depth (mm)
• Ae - Aggregate embedment
  – Ball penetration test
  – Negative allowance
• Absorption of binder by:
  – pavement
  – aggregate (not common)
  Allowances are cumulative

Step 6 – Design binder application rate $Bd$
  
  $Bd = Bb + As + Ae$
  
  • Round to nearest 0.1 L/m²

Reality Check
Will this work considering
• The conditions at time of placement
• The resources that will be available
• The traffic stresses

Double/double Seal Design
Design method applies if both applications applied within 24 hours

First Application (larger aggregate)
  – $Vf1$ reduced as voids are partly filled by smaller aggregate
  – Solid line in Figure 2.1 & 2.2 (Update to D/D design)
  – Same adjustments & allowances as single/single design added

Second Application (smaller aggregate)
  – $Vf2$ dotted line in Figure 2.1 & 2.2 (Update to D/D design)
  – Same process as single/single design
  – BUT NO ALLOWANCES for
    • Surface texture
    • Embedment
    • Pavement absorption

Basic Voids Factor $Vf$ for D/D Seal
0 – 500 v/l/d
**Geotextile Reinforced Seals**

Design procedure

1. Seal design as described
2. Add fabric retention allowance $A_R$
   
   (for a 140g/m² ~ 0.9 L/m²)
3. Apportion binder to bond coat
   
   Bond coat - 0.6 L/m²
4. Second application of binder
   
   Total minus bond coat application (e.g. 2.8 – 0.6 = 2.2)

**Aggregate spread rate ($m^2/m^3$)**

- Calculated from ALD of aggregate
- Spread rate (ASR) in $m^2/m^3$
- General work = $900/ALD$
  
  - varies for traffic and type of binder
  - ranges from $900/ALD$ to $750/ALD$
  - in practice, designed to nearest 10 $m^2/m^3$

**Example of S/S seal design**

**Site Details**

- Traffic
  - 2 lanes, each 3.6m
  - AADT = 800
  - % EHV = 10%
- Existing surface
  - Aggregate: 10mm
  - Texture: 1.2mm
  - No cracking

**Proposed Reseal:** 14mm

**Binder:** C170

**Example of S/S seal design**

**Step 1 – Input Information**

- **Design Traffic**
  
  - For 2 lanes = ½ AADT
  - $DT = \frac{1}{2} \times 800 = 400$ v/l/d
  - EHV = 10%
- **Aggregate**
  
  - Crushed
  - $FI = 22\%$
  - ALD = 8.5mm
Example of S/S seal design

Step 2 – Determine Vf

\[ Vf = 0.18 \text{ L/m}^2/\text{mm} \]

Example of S/S seal design

Step 3 – Adjustments for aggregate & traffic

- \( \text{Va} \) – Table 2.1
  - Fi – 22%
  - Va = 0

- \( \text{Vt} \) – Table 2.2
  - EHV = 10%
  - Road geometry –
    - Vt = 0

Example of S/S seal design

Step 4 – Determine design voids factor VF

- \( VF = Vf + Va + Vt \)
  - Vf = 0.18
  - Va = 0
  - Vt = 0

\[ VF = 0.18 \text{ L/m}^2/\text{mm} \]

Example of S/S seal design

Step 5 – Calculate basic binder rate Bb

- \( Bb = VF \times ALD = 0.18 \times 8.5 \)

\[ Bb = 1.53 \text{ L/m}^2 \]

Example of S/S seal design

Step 6 – Calculate design binder rate Bd

- \[ Bd = Bb + As + Ae \]
  - No embedment. \( Ae = 0 \)
  - Surface texture = 1.2mm
  - As = 0.3 l/m^2

\[ Bd = 1.53 + 0.3 = 1.8 \text{ L/m}^2 \]

(round to nearest 0.1L/m^2)

Loose aggregate spread rate for C170, 320, multigrade

<table>
<thead>
<tr>
<th>Traffic conditions</th>
<th>Aggregate Spread Rate (m^2/m^3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic &gt; 200 v/l/d</td>
<td>900 / ALD</td>
</tr>
<tr>
<td>Very low traffic ≤ 200 v/l/d</td>
<td>850 / ALD</td>
</tr>
</tbody>
</table>

Spread Rate = 900/8.5 = 105 m^2/m^3