**Content**

- Brief history of development
- Why Surface Dress
  - Design
- Binders for Surface Dressing
  - Petrol
  - Asphalt
  - Factors affecting
- Changing climate and influencing the market
- The Future

**History**

- Road Surfacing
- Crushed Stone
- Bitumen Emulsions
- Hot Mix
- Cold Mix
- Polymer Modified
- Micro surfacing

**Why Surface Dressing?**

- Seals the road surface from water
- Prevents further disintegration and prolongs life
- Improves skid resistance
- Reduces surface spray
- Enhances appearance
- In a cost effective way
Types of Surface Dressing

- Single Dressing
- Racked-in Dressing
- Double Dressing
- Inverted Double Dressing
- Sandwich Dressing

Surface Dressing Design

- Objectives
- Site variables
- Binder types
- Design process
- Binder spread rates
- Good practice

Site variables

- Climate
- Exposed or shaded
- Flat or hilly
- Dry or humid
- Underlying surface properties
- Traffic levels
- Public safety

Binder Requirements

- Binder must be:
  - Adhesive
  - Waterproof
  - Inexpensive
  - Readily available
  - Sufficiently fluid to spray, wet road surface and chippings
  - Resistant to traffic
- Weather:
  - Too fluid in hot weather
  - Too stiff in cold weather

Road Design

- Wrongly specified dressing type
- Wrongly specified binder type or spread rate
- Not considered variability with exposed and shaded area hardness
- Poor subbase and pre work planning
  - Fill potholes and ruts
  - Pad clay very porous and uneven surface
  - Not sealing freshly cut asphalt surfaces

Weather

- Road surface temperature
- Dampness of road
- Did it rain soon after surface dressing
  - Cutsup into the surface
- Too hot and humid allows breaking of prime emulsion/staining
Binder Application

- Spraying Viscosity < 0.3 Pa.s (max) at 100-180°C
- At 25°C Bitumen > 1,000,000 Pa.s (min)
- Low Temperature
  - Too viscosity of spray
  - Unable to "set" of bitumen
  - Unable to build up adhesion
- High Temp
  - Low viscosity
  - Sales – risk of burn
- Need to balance viscosity with safety.

Base Binder

- Cut
- Emulsify
- Cut-back
- Emulsion

Cutback v Emulsion

Advantages
- Rapid advance
- Low cost of binder
- Environmental
- Compatibility
- High tensile strength
- Early age bonding

Disadvantages
- Low setting temperature
- Loss of early tensile bonding
- Environmentally friendly
- Slow initial bonding
- Risk of better failure at lower water

Cutbacks

- Contain 10-15% of solvent such as kerosene, white spirit or naphtha
- Solvent can soften underlying layers causing unevenment/setting up
- Solvent presents a flash or explosion risk
- Use at high temperature presents a burns risk
- Solvent remains after 12 months so must cut back hard binder to reduce setting up
- Requires repeated addition of wetting agent to give active adhesion
- Requires pre-coated or lightly coated aggregates
- Very water-soluble sensitive
- Emissions to Atmosphere affecting O3/DME layer and CO2 levels.

FLUX LOSS OF CUT-BACK CURED OUT OF DOORS - UNCHIPPED

Loss of flux (% of total flux in cut-back)

Curing time - days

- 0%
- 10%
- 20%
- 30%
- 40%
- 50%
- 60%
- 70%
- 80%
- 90%
- 100%
**What Is an Emulsion**

- Dispersion of two immiscible liquids made mutually compatible by the use of surfactants.
- In general, this involves the use of solvents.
- Emulsions in the main are cationic in nature.

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**Emulsifier**

- Anionic Emulsion
  - Adhesion to acidic / neutral aggregate
  - Safety
    - low spraying temperature
  - Environmental
    - release of water
  - Slow Break
    - Breaking process is dependent on rate of evaporation of water
    - high humidity = very slow break.

- Cationic Emulsion
  - Adhesion to Basic Aggregate
  - Aggregate interrupts Breaking
  - Environmental
    - release of water
  - Safety
    - low spraying temperature
  - Slow Adhesion Build-up
    - no instantaneous 'glue'
Polymer-modified Emulsion

- Galenic
- Improved Strength
- Improved Flexibility
- Improved Temperature Susceptibility
- Improved Adhesion
- Skimming
  - at high-temperature / humidity

<table>
<thead>
<tr>
<th>BINDER</th>
<th>RESIDUAL BITUMEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cutback 100 tonnes x 90%</td>
<td>90 tonnes</td>
</tr>
<tr>
<td>K1 - 75 100 tonnes x 68%</td>
<td>68 tonnes</td>
</tr>
<tr>
<td>Difference 22 x 100</td>
<td>22.4%</td>
</tr>
<tr>
<td>Cutback 100 tonnes x 90%</td>
<td>90 tonnes</td>
</tr>
<tr>
<td>K1 - 75 132.4 tonnes x 68%</td>
<td>90 tonnes</td>
</tr>
</tbody>
</table>

What Is Fit for Purpose?

- Emulsion/cutback must meet requirements for storage and application.
- Emulsion break characteristics and cohesion development must be sufficient to allow early trafficking or loading.
- Cured binder within system must cope with trafficking and environmental conditions.

<table>
<thead>
<tr>
<th>Tonne of product</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cut-back 90 tonnes residual bitumen</td>
</tr>
<tr>
<td>Emulsion 68 tonnes</td>
</tr>
<tr>
<td>Intr. 32.4%</td>
</tr>
</tbody>
</table>

Application

- What is the application method and temperature?
- How soon do I want to apply traffic?
- How soon can I sweep a surface dressing?
- Do I need special plant for applying?

Performance Testing

- Binder
- Cohesive strength using vials pendulum or force ductility.
- Rheology using Dynamic shear Rheometer.
- Adhesion using plate shock or water sensitivity test.
- Low temperature fragility using plate shock or vase.
Bitumen Emulsion Binders

<table>
<thead>
<tr>
<th>Type of Surface</th>
<th>Low Traffic Category (See Table 3)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nominal Size of Chipping (mm)</td>
</tr>
<tr>
<td>Very Hard</td>
<td>Not recommended</td>
</tr>
<tr>
<td>Hard</td>
<td>1.3</td>
</tr>
<tr>
<td>Normal</td>
<td>1.3</td>
</tr>
<tr>
<td>Soft</td>
<td>2.0</td>
</tr>
<tr>
<td>Very Soft</td>
<td>Not recommended</td>
</tr>
</tbody>
</table>

The Breaking Process

1. Overcoming Particle Repulsion
2. Close Approach
3. Agglomeration Begins
4. Coalescence
5. Breaking
### Bitumen Behaviour - Thermoplastic

- **Hot**
  - Soften up
- **Cold**
  - Brittle Fretting

**Difference between softening point and brittle point should be as great as possible**

### Bitumen Behaviour - Visco-elastic

- **High Speed**
  - Spring
  - Elastic (rigid)
- **Low Speed**
  - Dashpot
  - Viscous (Soft)

**Elastic behaviour is preferable**

### Service Range

<table>
<thead>
<tr>
<th></th>
<th>195pen</th>
<th>50pen</th>
<th>450pen</th>
<th>Polymer Modified</th>
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</thead>
<tbody>
<tr>
<td>Softening Point</td>
<td>39</td>
<td>50</td>
<td>28</td>
<td>76</td>
</tr>
<tr>
<td>Brittle Point</td>
<td>-20</td>
<td>-10</td>
<td>-30</td>
<td>-25</td>
</tr>
<tr>
<td>Range</td>
<td>59</td>
<td>60</td>
<td>56</td>
<td>101</td>
</tr>
</tbody>
</table>

### Plasticity Range Improvement

### The "Service Range" Concept

### Polymer Modification Improves:

- Service Range
- Cohesive Strength
- Elastic Recovery
- Rheological Behaviour
- Adhesion
Toughness-Tenacity

1000mm/min

Steel Probe

Binder Sample

Rapid Tensile Test
- Measures "stiffness" & elasticity
- Indicates presence of polymer
- Performed at a range of temperatures

Toughness-Tenacity

Probe

"Tail"

Binder

Improved Tensile Properties

- Toughness-tenacity
- Rapid tensile test
- Polymer resin motion
- High initial resistance
- Continued resistance to force

Rheological Measurements

- Rheology = flow / deformation
- Measure stiffness as a function of:
  - Temperature
  - Frequency
  - Load
  - Time
- Gives end performance data

Types of Measurement

- Temperature Sweep
  - Measure stiffness vs temperature
  - Single frequency
  - Used to predict effective temperature range
- Frequency Sweep
  - Measure stiffness vs frequency
  - Discete temperatures
  - Used to predict effect of traffic speed

Spindle: 8mm or 20mm
Sample 1-2mm thick

Oscillating Spindle

Bitumen Sample

Fixed Bottom Plate

Heat
Temperature Sweep

- High stiffness at high temp = 1000psi
- Low stiffness at low temp = 3000psi
- Rate of change reduced

Frequency Sweep

- Lower stiffness at high frequency
- Higher stiffness at low frequency
- More resistant to high speed traffic
- Less chance of fretting
An English Cutback County Sold on Emulsion

- Why should they change.
- Why hadn’t they.
- What made them change.
- What were their fears.
- What happened.
- How do they feel now.
Why hadn’t they?

- Very heavily trafficked roads.
- Warmest County in UK
- Happy with history of using cutback and didn’t feel the need to change.
- Fearful of Emulsion early life traffic tolerance

What made them change?

- In 1998 county used 1000 tonnes of polymer cutback on their roads.
- In 1999 change in surface dressing contractor.
- Contractor presented number of presentations on improvements on emulsion developments during the mid to late 90’s.
- Contractor convinced county to change totally to emulsion over a 2 year period.

What were their fears?

- Will emulsion cope with heavy trafficked roads.
- Will it Cost more.
- Will emulsion fail to hold the chips instantly as cutback does.

What happened.

Due to advances in understanding and controlling the surface dressing process:
1) Reactivity with aggregate gave an instant grip and historical levels of traffic management were not required.
2) Emulsion systems were much more forgiving in wet weather.
3) 100% use of pmh systems with wider temperature susceptibility window greatly reduced lifting up issues.
4) Increase in number of different aggregates used.

How do they feel now?

- Original programme was 1000 tonnes of cutback.
- Equated to 12-1300 tonnes of emulsion at increased cost per m^2
- Excellent track record over 3 years.
- Several excellent testimonials to the contractor from the county.
- Volumes for 2003 up by 50% to 2000 tonnes of emulsion

Conclusion

A County sold on cutback historically is now 100% committed to the use of emulsion and plan to increase the volume of emulsion further in the future.
The Future

- Performance Specification
  - HAPAS certification
- Greater Use of Modified Stabilisers
- Controlled Breaking Emulsions
- Partnership
  - Supplier and Appor Together
Acknowledgments

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