High Performance Asphalt and Binders

Donna James
EME2 – The Future
Focus of research

• Practical experiment to demonstrate fatigue endurance limit
• Continue to focus on improving construction, specification and auditing
High performance asphalt and binders

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High performance asphalt

• EME introduced in UK in 2006
• Uses a standard specification from French experience
• Design charts made conservative estimate of properties
• Can still be more cost effective in UK to use “traditional asphalts” due to high binder content
• Binder properties considered critical
EME2 specimen

0  50  100  150  200  250

(mm)
Design Process

Select candidate mixture composition

Test workability

Test moisture susceptibility

Manufacture slabs/test specimens

Test rut susceptibility

Test fatigue properties

Test stiffness properties

Mixture OK?
Mix preparation
Gyratory Shear Compactor
(Presse à Cisaillement Giratoire - PCG)

<= 6% air voids after:
- 80 gyrations for 0/10mm
- 100 gyrations for 0/14mm
- 120 gyrations for 0/20mm

- BS EN 12697:31
Wheel Tracker - Large Device
• Automated device
• Linked to the computer
• 5 points along the sample checked for deformation
• 3 points across the sample
Richness modulus

Calculate surface area of aggregate

Separated into 4 sieve size ranges

- >6.3mm
- 6.3mm – 0.315mm
- 0.315mm – 0.080mm
- <0.080mm
Binder Content

At the target binder content the Richness Modulus $K$, determined in accordance with Annex B must be greater than or equal to 3.4.

The **minimum binder contents** must not be less than:

- EME2 0/10 5.6%
- EME2 0/14 5.4%
- EME2 0/20 5.2%

During production of the EME 2, the binder content must not be less than 0.3% below the design target binder content, nor more than 0.6% above.
The binder for use in EME base/binder course asphalt mixtures should preferably be 10/20 grade bitumen, targeting a penetration of 15-20, and in accordance with EN 13924 as elaborated in Annex A of the Draft Specification Requirements given in TRL Report 636.

10/20 and 15/25 are permitted for EME2 in France.
### Table A Binder characteristics (ref prEN 13924)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Test method</th>
<th>Unit</th>
<th>10/20 pen</th>
<th>25/25 pen</th>
<th>Test frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penetration at 25°C</td>
<td>EN 1426</td>
<td>0.1 mm</td>
<td>10 - 20</td>
<td>15 - 25</td>
<td>D</td>
</tr>
<tr>
<td>Softening point</td>
<td>EN 1427</td>
<td>°C</td>
<td>63 - 73</td>
<td>60 - 70</td>
<td>W</td>
</tr>
<tr>
<td>Penetration index, max</td>
<td>prEN 13924</td>
<td>-</td>
<td>+0.7</td>
<td>+0.7 max</td>
<td>W</td>
</tr>
<tr>
<td>Fraass breaking point, max</td>
<td>EN 12593</td>
<td>°C</td>
<td>Target mean 0 max</td>
<td>Target mean 0 max</td>
<td>A (Q)</td>
</tr>
<tr>
<td>Viscosity at 135°C, min</td>
<td>EN 12595</td>
<td>mm²/s</td>
<td>1100</td>
<td>900</td>
<td>A (Q)</td>
</tr>
<tr>
<td>Flash point, minimum</td>
<td>EN 2592</td>
<td>°C</td>
<td>245</td>
<td>245</td>
<td>A</td>
</tr>
<tr>
<td>Solubility, minimum</td>
<td>EN 12592</td>
<td>% (m/m)</td>
<td>99.0</td>
<td>99.0</td>
<td>A</td>
</tr>
<tr>
<td>Pendulum cohesion, min</td>
<td>EN 1358/kor SHW Cl 939</td>
<td>J/cm²</td>
<td>0.5 (3)</td>
<td>0.5 (3)</td>
<td>A (Q)</td>
</tr>
</tbody>
</table>

**Binder characteristics after EN 12607-1 (RFFOT)**

| Change of mass, max                           | %           | 0.5 | 0.5 | A         |
| Retained pen 25°C, min                       | EN 1426     | %   | 65 (3) | 65 (3) | A (Q) |
| Increase in softening point, maximum         | EN 1427     | °C  | 8   | 8        | A (Q) |
| Fraass breaking point, min                   | EN 12593    | °C  | Target mean +2 max | Target mean +2 max | A (Q) |
| Pendulum cohesion, min                       | EN 1358/kor SHW Cl 939 | J/cm² | 0.5 (3) | 0.5 (3) | A (Q) |
Sensitivity to moisture

Duriez test
Unconfined compression test
Before and after conditioning in water
Ratio must be $\geq 0.75$
Standard: NF P 98 251-1 (AFNOR)
10 samples compacted
8 samples selected on voids criteria
Conditioning for 7 days
   - 4 in water (r)
   - 4 in air (R)
8 samples crushed
EME2 finished surface
EME2 Summary

- More than 20 years proven track record in France
- Available as 20mm, 14mm, 10mm
- Excellent deformation resistance
- Outstanding waterproofing properties
Assessing fatigue resistance
Assessing fatigue resistance

Where fatigue considered to be of particular importance:
- Specify richness modulus $\geq 3.6$
- Determine resistance to fatigue using French standard
Assessing stiffness
Assessing stiffness

For trunk road network:

- Mean ITSM of 6 150mm diameter cores taken from a trial strip shall not be less than 5.5 GPa
Foundation Stiffness

EME2 must be compacted on a subbase with an initial minimum foundation surface stiffness modulus of 120MPa.

Note: On French motorways, grave-bitumen or cement-bound sub-bases are generally used.
PMBs

• Currently PMBs are not accounted for in UK design methodology
• Risk based approach via a Departure from Standards procedure
Geosynthetics

- Not currently covered by UK standards
- Not permitted as a method to reduce asphalt thickness
- Primarily used to delay onset of reflection cracking
Asphalt (Moisture Susceptibility)

Covered by SATS test EN12697-45
Pressure Vessel

1st

2nd

3rd

4th

5th

Specimen tray

Partially filled with water (5mm ± 5mm above the 5th tray)

Porous disc for standard triaxial test (5mm thickness, Ø 100mm)
Asphalt Durability

The durability of adhesion in base and binder course mixtures designed in accordance with Clause 929 and to be used on trunk roads including motorways shall be determined by testing in accordance with Clause 953. The SATS Durability Index of the mix components shall be above 80%.