Recycled aggregates, TfL trial

Driving resource efficiency

The construction industry is facing increasing pressure from policymakers to become more resource efficient due to it being both the UK’s largest industrial producer of waste and largest consumer of natural resources. According to figures exceeding more than 400 million tonnes of material, Highways England’s £15.7 billion Road Investment Strategy, significant improvements are planned for England’s strategic roads over the next five years which will require the sector to supply huge amounts of finite resources. This renewal programme also gives the highways sector a unique chance to lead the wider construction industry in the push to adopt a more sustainable approach to materials.

"Much of the inherent value of Britain's road network is in the billions of tonnes of asphalt that make up the surface of its highways," said Tim Metcalf, aggregates and asphalt director at FM Conway. “Asphalt is 100 per cent recyclable and, with over 50 per cent of the strategic road network likely to be resurfaced by 2020-21, vast quantities of the material could be recovered for reuse.”

Spacer alert!
Independent family-run business

£296m turnover and 2,800-strong workforce

50 years of innovation and learning

Strong cross-sector partnerships

Secure supply and self-delivery

But what is it?
- High recycled content
- On going performance
Overview of UK Geology (the motivation)

Sand and gravel (and lots of it)

....and for those of you wondering about hardstone, well, lets just say its distinctly lacking in the south east...

Source: BGS, 2013
Supports and drives the passion for self delivery

OUR CIRCULAR ECONOMY
A growing need for security and efficiency

Active storage of 7,500 tonnes of ‘Penetration Grade’ Bitumen

Polymer modifier added in 2016, further 400 tonnes of storage
Sustainability, what is it?

- A complex concept
- A balancing act
- Meets the needs of the present, without comprising the needs of the future
Meeting today’s needs .......
.....without compromising tomorrow
Changing design philosophy

No Change in Specification or Quality
Getting best value

True Recycling = Future of Asphalt
Some background before the movie

Mill Hill – a non-event carriageway with one-way traffic and involved resurfacing across all three lanes of the highway, laying 300t of asphalt
Specification
Certification of thin surface course – Cl.942

- Introduction of increased working zones for improved safety led to;
  - A reduction in the use of hot rolled asphalt (HRA)
    (no space for chipping machine without full closure)
  - Development of materials used in France and Germany, to allow a combination of method and performance based approach
    - adjusted for UK spec (PSV and retained texture)
  - Proprietary systems that were;
    - Machine laid, less than 50mm thick
    - Negatively textured (reducing noise)
    - More rut resistant

- The output, a certification scheme with a 5 year guarantee

Limitations:
- Life expectancy – limited by surface texture requirements: 7-15 years depending on conditions (traffic, thickness etc)
  - Producing materials to meet previous texture depth requirements led to open materials which were less durable
  - (This subsequently led to Scottish developments of TS2010)...more on that tomorrow!
Cl.942, what does it look like?

TABLE 9/17: (05/18) Road/Tyre Noise Levels

<table>
<thead>
<tr>
<th>Level</th>
<th>Equivalence to Traditional Surfacing Materials</th>
<th>Road Surface Influence RSI</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Very quiet surfacing material</td>
<td>-3.5 dB(A)</td>
</tr>
<tr>
<td>2</td>
<td>Quieter than HRA surfacing materials</td>
<td>-2.5 dB(A)</td>
</tr>
<tr>
<td>1</td>
<td>Equivalent to HRA surfacing materials</td>
<td>-0.5 dB(A)</td>
</tr>
<tr>
<td>0</td>
<td>Noisier than HRA Surfacing Materials</td>
<td>+1.2 dB(A)</td>
</tr>
<tr>
<td>NR</td>
<td>No requirement</td>
<td>No requirement</td>
</tr>
</tbody>
</table>

35 (05/18) The influence of the road surface on traffic noise using the statistical pass-by method shall be established using the above table. Where noise measurements are made, the surface texture RSI shall be determined in accordance with BS EN 13036:1-2010. The macrotexture depth of the nearside wheel-track in front of a test location must be within 10 per cent of the average macrotexture measured along the site.

TABLE 9/18: (05/18) Reference speeds (km/h-1) for different road speed categories

<table>
<thead>
<tr>
<th>Vehicle category</th>
<th>Road speed category (km/h-1)</th>
<th>Medium</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>80</td>
<td>110</td>
<td></td>
</tr>
<tr>
<td>H1</td>
<td>70</td>
<td>90</td>
<td></td>
</tr>
<tr>
<td>H2</td>
<td>70</td>
<td>90</td>
<td></td>
</tr>
</tbody>
</table>

Category L vehicles — light vehicles including passenger cars and car derived vans, excluding vehicles towing trailers.
Category H1 vehicles — commercial tracks with 2 axles and greater than 3.5 tonnes.
Category H2 vehicles — commercial tracks with more than 2 axles and greater than 3.5 tonnes.

39 (05/18) The apparatus described in ISO 11819-1: 2002 Section 5 are used. The frequency range of between 100 and 1500 Hz (centre frequencies of the one-third octave bands) should be covered.

40 (05/18) The macrotexture of the road surface used for the noise assessment shall be measured in the nearside wheel-track along the whole length of test material in accordance BS EN 13036:1-2010. The macrotexture depth of the nearside wheel-track in front of a test location must be within 10 per cent of the average macrotexture measured along the site.

41 (05/18) The microphone location at each measurement site shall be recorded accurately and marked with appropriate methods such that the position can be readily identified for a period of at least two years.

42 (05/18) When sufficient vehicle pass-bys have been measured, a linear regression analysis shall be performed in accordance with ISO 11819-1: 2002, clause 9.1. In the case of the high-speed category, measurements must not be taken of vehicles traversing at speeds of less than 60 km/h in accordance with AFNOR Standard S31-119.

43 (05/18) For each category of vehicle defined in Table 9/18, the Vehicle Sound Level, L_v, shall be calculated as the arithmetic sound level of the regression line at the reference speed for the category of road. All levels shall be calculated to two decimal places and rounded to one decimal place.
Assessment Procedure

- Stage 1: Assessment of data
- Stage 2: Assessment of production control
- Stage 3: Laboratory Testing
- Stage 4: System installation trial
- Stage 5: Performance trial (if required)
- Stage 6: Certification
Can it be done?

Recycled Asphalt Pavement Trial 2016
Absolutely!

Let's explore key points from the video

- ‘top quality aggregates’ – how do we assess this?
- ‘throwing away aggregate that still has life’ – what does that mean?
- ‘high property aggregate back into base material that is being wasted’
  and ‘introduces additional operation’ – but what is it?

(Let also not forget about designing the mixture for recycling)

Source: Recycled Asphalt Pavement Trial 2016, Video
‘Top quality aggregates’

Prior to commencing the works cores are taken to assess;

• The nature of the existing structure
• Testing for tar (hazardous material)
• The psv of the stone
‘Aggregate back into base is being wasted’

For the trial;
• existing Stone Mastic Asphalt (SMA) surfacing was removed,
• processed to take out undersize or oversize material
• and held ready to incorporate back in to the new asphalt mixtures
Screening of RA

Points to note:

The material is treated as you would virgin – the linear quarry

Moisture content targets on RAP fractions

Particle size distribution assessed, as is pen and softening point

New technologies being reviewed to optimise yield from plannings
And of course designing for recycling

Laboratory assessment of;
- mixture performance
- compactability

The inclusion of FMC proprietary pmb binder

PMB Benefits
- Improved elasticity and viscosity
- Increased resistance to rutting and deformation
- Reduced chances of fatigue cracking
- Reduced temperature susceptibility....
## Table 1: Trial mixture approval test results 14mm SurePhalt Pmb, 50% RAP

<table>
<thead>
<tr>
<th>Property Assessed</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air voids content determined in accordance with BS EN 12697-8:2003 (%)</td>
<td>2.1</td>
</tr>
<tr>
<td>Mean rut depth, RDAIR, at 10 000 cycles (mm)</td>
<td>2.2</td>
</tr>
<tr>
<td>Mean proportional rut depth, PRDAIR, at 10 000 cycles (%)</td>
<td>5</td>
</tr>
<tr>
<td>Binder Drainage BS EN 12697-18:2004 - Schellenberg Method (%)</td>
<td>0.25</td>
</tr>
<tr>
<td>Fuel Resistance BS EN 12697- 43: 2005 (overall result)</td>
<td>Good</td>
</tr>
<tr>
<td>Resistance to Jet A1 fuel, A (%)</td>
<td>2.4</td>
</tr>
<tr>
<td>Resistance to Jet A1 fuel, B (%)</td>
<td>0.9</td>
</tr>
<tr>
<td>Sensitivity to water - BBA specification Appendix A.2, March 2011</td>
<td></td>
</tr>
<tr>
<td>Mean stiffness modulus (MPa)</td>
<td>4519</td>
</tr>
<tr>
<td>Mean retained stiffness (%)</td>
<td>107.6</td>
</tr>
<tr>
<td>Water Sensitivity BS EN 12697-12:2008, Indirect Tensile Strength Ratio (ITSR) (%)</td>
<td>99</td>
</tr>
<tr>
<td>Stiffness Modulus - BS EN 12697-26:2004 (E) - Annex C, Mean (MPa)</td>
<td>4119</td>
</tr>
<tr>
<td>Indirect Tensile Fatigue Test (ITFT) BS DD ABF: 1995</td>
<td></td>
</tr>
<tr>
<td>Strain at 10⁶ cycles (microstrain)</td>
<td>44.1</td>
</tr>
<tr>
<td>Life at 100 microstrain (cycles)</td>
<td>64,497</td>
</tr>
<tr>
<td>Polished Stone Value BS EN 1097-8: 2009, corrected value</td>
<td>63</td>
</tr>
</tbody>
</table>

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And more data... 2017 one year on

Post installation monitoring
1. Torque Bond Test.
2. Surface texture, initial (immediately after laying), followed by 12 and 24 month intervals thereafter.
3. Rolling Straight Edge.
4. Road Noise Survey.
5. SCRiM

SCRiM – results to date are equivalent to conventional material

(Investigatory level of 0.4 is expected for the site)
What the client said...

• ‘its not fiction anymore, its reality’

• ‘if we don’t start looking after it today we won’t have anything left for the future’

• ‘potential benefits of the trial are industry changing’
‘Industry changing’ ....or at least it has the potential
But...

2 (08/08) Reclaimed asphalt may be used in the production of bituminous surface course, binder course, regulating course and base. Unless otherwise specified in Appendix 7/1, the use of reclaimed asphalt shall be in accordance with:

(i) the relevant British Board of Agrément HAPAS Road and Bridges Certificate for surface course mixtures specified in Clause 942;
(ii) BSI PD 6691, B.2.4.4 for Asphalt Concrete mixtures (macadam);
(iii) BSI PD 6691, C.2.3.4 for Hot Rolled Asphalt mixtures;
(iv) BSI PD 6691, D.2.2.3 for Stone Mastic Asphalt mixtures.

Other recycled materials shall only be used in bituminous mixtures with the approval of the Overseeing Organisation. The mixed material shall comply with the requirements of all the relevant clauses in this Series.

2 (08/08) Reclaimed Feedstock

3 (08/08) All reclaimed material shall be pre-treated before use such that it is homogeneously mixed and the maximum particle size does not exceed 32 mm.

Properties of Binder

4 (08/08) The fresh bitumen added to the mixture shall not be more than two grades softer than the nominal grade for the mixture given in Table 12 of BSI PD 6691. Checks on the penetration of the binder recovered from the reclaimed asphalt, together with a calculation of the properties of the combined binder, shall be carried out in accordance with the relevant parts of BS EN 13108. When more than 10% of reclaimed asphalt is incorporated in a mixture, tests on binder recovered from the mixture shall be carried out in accordance with BSI PD 6691 13.3.6.2. The results shall be within the limits set out in BSI PD 6691 13.3.6.2.

(08/08) Mixed materials containing more than 25% reclaimed asphalt

5 (08/08) When more than 25% of reclaimed asphalt is incorporated in a designed base or binder course mixture, cores taken to assess compliance with Clause 929.12 or Clause 930.14 shall also be tested for stiffness in accordance with BS EN 12697-26 (ITSM method 20°C). The frequency of testing shall be agreed with the Overseeing Organisation prior to the commencement of works.

6 (08/08) The stiffness of the mixture shall comply with the appropriate category from Table 9/1.

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TABLE 9/1: (08/08) Stiffness Categories for Designed Base and Binder Course Mixtures Incorporating Greater than 25% Reclaimed Asphalt

<table>
<thead>
<tr>
<th>Nominal binder grade of mixture</th>
<th>Stiffness category ($S_{95}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10/20</td>
<td>5500</td>
</tr>
<tr>
<td>15/25</td>
<td>5500</td>
</tr>
<tr>
<td>30/45</td>
<td>2800</td>
</tr>
<tr>
<td>40/60</td>
<td>1800</td>
</tr>
</tbody>
</table>

SERIES 900
ROAD PAVEMENTS - BITUMINOUS BOUND MATERIALS
The reality
...however, a wiseman once said....

Everything that can be counted does not necessarily count: everything that counts cannot necessarily be counted. - Albert Einstein
Relating mixture and design to performance

We already know contact patch and stone size can influence skid but what about psv?

The PSV test;
• does not predict performance
• does not lead to the more sustainable use of locally available resources (or blended)
• does not guarantee that our roads will be safer.

What about the friction after polishing (FAP) test? (Wehner schulze)
Alternative approaches to consider - moving towards performance?

Road Test Machine #1

Wehner Schulze (Friction After Polishing – FAP) Test
Measuring the mixture - Wehner Schulze Vs. PSV
Where does this leave us?

• We are now in a position to understand many of the requirements and some of the limitations

• We are capable of managing the risk through use of selective milling and testing

• We can make use of locally available aggregates and improve their usage

• We can meet the needs of today without compromising tomorrow

• We do need to keep innovating - it is complex but it can and is being done
V speeds are considered by the aviation industry as best practice to maximise safety, performance or both.

A final thought - We’re taking off, are you?