Road Trials of Low Noise High Performance Asphalt Surfacings

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– D. Markham, M. Simms & T. Smith (Mineral Products Association)
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- material suppliers; contracting companies;
- area managers; local highway authorities;
- universities;
- AECOM’s delivery team: Jessica Tuck, Dr Paul Edwards, Dr Matthew Muirhead, Dr Helena Lacalle, Dr Giacomo D’Angelo…. (the list continues)

**Big thanks to all of you.**
Collaborative Research Projects

The primary objective of these projects are “to ensure that asphalt surfacings continue to deliver value for money on the strategic road network (SRN) and to maximise the benefit from innovation”

<table>
<thead>
<tr>
<th>Project themes</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1</strong></td>
<td>Next generation low noise surfacing materials – Road Trial, Installation and Assessment.</td>
</tr>
<tr>
<td><strong>2</strong></td>
<td>Automated QA test methods.</td>
</tr>
<tr>
<td><strong>3</strong></td>
<td>Low Temperature Asphalt/Warm Mix Asphalt (WMA) Evaluation.</td>
</tr>
<tr>
<td><strong>4</strong></td>
<td>Specification of Construction Joints.</td>
</tr>
<tr>
<td><strong>5</strong></td>
<td>Review of Asphalt Recycling Practices.</td>
</tr>
<tr>
<td><strong>6</strong></td>
<td>Evaluation of existing demonstration sites with Radio Frequency Identification (RFID) Tags.</td>
</tr>
<tr>
<td><strong>7</strong></td>
<td>Noise Evaluation.</td>
</tr>
</tbody>
</table>
Roads today
“Our roads connect the country together and our network helps four million journeys to be made safely and reliably each day. We want the people who use them to be safe and a big part of that is ensuring we have a good quality road surface too. Some people may not be aware of the incredible engineering that has taken place beneath their wheels to make them happen. But just like a cake, it really is a refined recipe.”

(Nicola Debnam, Highways England Director of Asset Development, Safety, Engineering and Standards, October 2018)
Next Generation of Asphalt Surfacing

Have been carried out under 3 consecutive collaborative projects:

<table>
<thead>
<tr>
<th>Aim</th>
<th>To review the surfacing materials worldwide with a view to developing the next generation of asphalt materials which has significantly enhanced <strong>durability, optimised noise and skid resistance characteristics.</strong></th>
</tr>
</thead>
</table>

Task 409 (2015/2016) – literature review, workshop, mix design and demonstration trial
Task 1-111 (2016/2017) – mix design optimisation and field trial on SRN
Task 1-444 (2017/2018) – further trials on SRN, inspection panel and launch event

<table>
<thead>
<tr>
<th>Literature Review</th>
<th>Workshop</th>
<th>Laboratory Design</th>
<th>Demonstration Trial</th>
<th>Field Trial</th>
</tr>
</thead>
</table>

Page 7
## Technology/Innovation Readiness Level

*(Paul Sanders, Highways England, October 2016)*

<table>
<thead>
<tr>
<th>Readiness Level</th>
<th>Description</th>
<th>Assessment Implication &amp; Further work recommendation</th>
<th>Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Basic principles observed and reported</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Technology concept and/or application formulated</td>
<td>(Further) Laboratory investigation and validation</td>
<td>Innovator</td>
</tr>
<tr>
<td>3</td>
<td>Analytical and experimental critical function and/or characteristic proof-of-concept</td>
<td>Demonstration / validation of concept trial (off HE network)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Technology validation in a laboratory environment</td>
<td>Demonstration / validation of concept trial (off HE network)</td>
<td>Innovator</td>
</tr>
<tr>
<td>5</td>
<td>Technology basic validation in a relevant environment</td>
<td>Trafficked demonstration / validation of concept trial (off HE network)</td>
<td>Innovator (+ HE or other sponsor)</td>
</tr>
<tr>
<td>6</td>
<td>Technology model or prototype demonstration in a relevant environment</td>
<td>Demonstration / validation of concept trial (on HE network)</td>
<td>Innovator / HE sponsor</td>
</tr>
<tr>
<td>7</td>
<td>Technology prototype demonstration in an operational environment</td>
<td>If acceptable, authorise for DfS on project basis</td>
<td>HE</td>
</tr>
<tr>
<td>8</td>
<td>Actual technology completed and qualified through test and demonstration</td>
<td>Develop standard/specification</td>
<td>HE</td>
</tr>
<tr>
<td>9</td>
<td>Actual technology qualified through successful mission operations</td>
<td>Authorise duplicate/ related technologies for Generic Network Approval. Publish new standard/specification in DMRB/MCHW</td>
<td>HE</td>
</tr>
</tbody>
</table>
Literature Review

CONSTRUCTABILITY

Traffic management

workmanship

Construction method

DURABILITY

Joints

Low permeability

Dense

Macro texture

Air voids

Binder

Filler

Mix design

Specification

QA/QC

Performance related criteria

Layer thickness

Bond coat

PMB, additives

PSV

Case Studies & Feedbacks from:

NOISE

Wet friction

SAFETY

Quality

Binder content

Binder

Aggregate

Literature Review Workshop Laboratory Design Demonstration Trial Field Trial
International Workshop

The workshop took place on 2nd June 2015, from 9am to 2pm, at Lea Marston Hotel in Warwickshire

What are your ideas for the next generation of asphalt surfacing for use on Highways England’s Network, that will increase durability without compromising the current performance of Specification for Highway Works (SHW) Clause 942?
International Workshop

- Laboratory
- Workshop
- Demonstration Trial
- Field Trial
- Literature Review
“Dual function layer” with Good Practice

- Better understanding of aggregate packing
- Improvements to mix design process
- Improving workmanship / operational upskilling / training
- Procurement and ‘risk sharing’
- Better feedback loop on performance
- Substrate condition
- Bond between layers
- Access / traffic management / full road closure
- Relationship with supply chain
- Temperature control (shuttle buggies)
Agreed Options to Investigate

• **Polymer Modified Hot Rolled Asphalt with smaller size of chipping:** The use of 6/10 mm pre-coated chippings at various application rates. The aim was to minimise noise through embedment of smaller size chippings. The Hot Rolled Asphalt (HRA) used in the project conformed to SHW Clause 943 (Performance Related Design Mixture) designated as HRA 35/14F surf PMB Class 2

• **Premium Asphalt Surfacing Systems (PASS):** PASS layer was the top idea amongst a range of other options. The PASS concept is based on a durable, low voided, dense body of material with improved surface characteristics (low noise, good macrotexture). The adopted nominal aggregate size was 0/10mm.

• **Benchmark = Thin Surface Course Stone Mastic Asphalt:** Produced in compliance with EN 13108-5 and SHW Clause 942. Thin Surface course control (0/10 mm TSC) to act as a benchmark mixture.
Premium Asphalt Surfacing Systems (PASS)

The Initial Works
## Laboratory Design and Assessment

### Tests

<table>
<thead>
<tr>
<th>Test</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mixture volumetrics (density and air voids)</td>
<td></td>
</tr>
<tr>
<td>Workability Assessment</td>
<td></td>
</tr>
<tr>
<td>Visual assessment of samples</td>
<td></td>
</tr>
<tr>
<td>Determination of surface texture to EN 13036-1</td>
<td></td>
</tr>
<tr>
<td>Determination of skid Pendulum Test Value (EN 13036-4)</td>
<td></td>
</tr>
<tr>
<td>Resistance to deformation measured by using wheel track testing</td>
<td>(small device in air) at 60°C to EN 12697-22</td>
</tr>
<tr>
<td>Resistance to moisture damage measured by Indirect Tensile Strength</td>
<td>(ITS) to EN 12697-12</td>
</tr>
<tr>
<td>Determination of noise by acoustic impedance tube method</td>
<td>(EN ISO13472-2)</td>
</tr>
</tbody>
</table>

### Project Stages

- **Literature Review**
- **Workshop**
- **Laboratory Design**
- **Demonstration Trial**
- **Field Trial**
Laboratory trials and design validations

Laying trial

Accelerated Load Testing

Simulative testing

HighTech Asphalt Mixer

Mechanical Tests

Photos taken at AECOM Specialist Laboratories in Nottingham
Demonstration Trial

Pilot Scale Trial
Tarmac - Alrewas Quarry Access Road – June 2016

Literature Review  Workshop  Laboratory Design  Demonstration Trial  Field Trial
0/10mm PASS PMB 45/80-60, 5.4% Binder Content

Literature Review  Workshop  Laboratory Design  Demonstration Trial  Field Trial
The materials

PMB class 45/80-60, 5.4% Binder Content
### Key Findings and Considerations

<table>
<thead>
<tr>
<th>Properties</th>
<th>Lab</th>
<th>Trial</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workability</td>
<td>✓</td>
<td>✓</td>
<td><strong>Excellent.</strong> Both materials were reported as relatively easy to produce and install. No foreseeable workability related issue.</td>
</tr>
<tr>
<td>Volumetrics – Air Voids</td>
<td>✓</td>
<td>✓</td>
<td><strong>Excellent.</strong> Between 3 and 6% air voids (Lab 1 &amp; Lab 2). Quality control measures for the production and installation of the materials to facilitate compliance with specifications.</td>
</tr>
<tr>
<td>Surface Macrotexture</td>
<td>✓</td>
<td></td>
<td>Lab (1.2mm) – <strong>acceptable</strong> and Trial (0.8mm) – <strong>low.</strong> Must optimise the gradation in order to increase the mean texture depth in future trials.</td>
</tr>
<tr>
<td>Skid Resistance</td>
<td>✓</td>
<td>✓</td>
<td>Both showed <strong>excellent</strong> Pendulum Test Values ≥ 70.</td>
</tr>
<tr>
<td>Noise Assessments</td>
<td>✓</td>
<td>✓</td>
<td><strong>Inconclusive</strong> acoustic impedance tube test results – SPB for the main trials.</td>
</tr>
<tr>
<td>Moisture Susceptibility</td>
<td>✓</td>
<td>✓</td>
<td>Showed <strong>good</strong> moisture susceptibility properties. ITSR: &gt;90% (Lab 1 &amp; Lab 2) and &gt;70% (Trial 1).</td>
</tr>
<tr>
<td>Wheel Tracking</td>
<td>✓</td>
<td>✓</td>
<td><strong>Excellent</strong> (Lab 1 &amp; Lab 2). At 10000 cycles (in air at 60ºC): wheel track slope &lt; 0.07mm/1000cycles, proportional rut depth &lt; 5% and rut depths &lt; 2.5 mm</td>
</tr>
</tbody>
</table>
"Excellent. Observations showed no material loss, cracking, or fretting"
Premium Asphalt Surfacing Systems (PASS)

The Road Trials
Field trial

The trial was completed on 9\textsuperscript{th} August (Night Time Works)/10\textsuperscript{th} August. The site location for the PASS trial is the A46 Hykeham to Carholme (Southbound).
Noise Measurements of PASS

Two measurements, 100m apart, at the trial site

SPB method but microphone at 4.5m rather than 7.5m

Correction factor of -2.5 dB(A) applied from comparison measurements (on another surface)

Road Surface Influence (RSI) values: -5.5 and -5.7 dB(A)

Good result – meets MCHW ‘very quiet surfacing material’ (Level 3)
# Key Findings and Considerations from the Road Trials

<table>
<thead>
<tr>
<th>Properties</th>
<th>PASS1</th>
<th>PASS2</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workability</td>
<td>✔️</td>
<td>✔️</td>
<td><strong>Excellent.</strong> Both materials were reported as relatively easy to produce and install. No foreseeable workability related issue.</td>
</tr>
<tr>
<td>Volumetrics – Air Voids</td>
<td>❌</td>
<td>❌</td>
<td><strong>Concern.</strong> Between 7 and 9% air voids. Quality control measures for the production and installation of asphalt materials to obtain dense body with open surface texture.</td>
</tr>
<tr>
<td>Surface Macrotexture</td>
<td>✔️</td>
<td>✔️</td>
<td><strong>Excellent.</strong> Average of 1.2mm and 1.3mm for both PASS mixtures.</td>
</tr>
<tr>
<td>Skid Resistance</td>
<td>✔️</td>
<td>✔️</td>
<td><strong>Excellent.</strong> Pendulum Test Values ≥ 70.</td>
</tr>
<tr>
<td>Noise Assessments</td>
<td>✔️</td>
<td>✔️</td>
<td><strong>Good</strong> result – meets MCHW ‘very quiet surfacing material’. Road Surface Influence -5.5 and -5.7 dB(A)</td>
</tr>
<tr>
<td>Moisture Susceptibility</td>
<td>✔️</td>
<td>✔️</td>
<td><strong>Good</strong> resistance to moisture (BS EN 12697-12); comparable to those obtained from the demonstration trial (Alrewas Quarry)</td>
</tr>
<tr>
<td>Wheel Tracking</td>
<td>✔️</td>
<td>✔️</td>
<td><strong>Good</strong> results comparable to those obtained from the demonstration trial (Alrewas Quarry)</td>
</tr>
</tbody>
</table>

**Date:** November 12, 2018

**Additional Information:**
- Field Trial
- Demonstration Trial
- Laboratory Design
- Workshop
- Literature Review
Imaging Analysis: X-Ray Computed Tomography (CT scan)

Note: bulk air voids was 7.5%
After 6 months (February 2018)

1 Introduction

AECOM as part of the collaborative research project led the project delivery team that completed the successful network trial and installation of the PASS on the A46 Hykeham to Carholme (Southbound) which is part of the Area 7 scheme. The trial was conducted on 8th/10th August 2017 (night time installation).

This technical note details the findings following a site inspection and visual condition survey using video imaging techniques on the A46 Hykeham to Carholme (Southbound) – Chainage 1675 to 1817.

<table>
<thead>
<tr>
<th>Material</th>
<th>August 2017 (BS EN 13836-1)</th>
<th>February 2018 (Laser Technique)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PASS 1</td>
<td>1.2</td>
<td>1.3</td>
</tr>
<tr>
<td>PASS 2</td>
<td>1.3</td>
<td>1.4</td>
</tr>
</tbody>
</table>
Summary

- **Durability**
  - In situ density
  - Resistance to moisture
  - Resistance to deformation

- **Safety**
  - Skid resistance
  - Macro-texture

- **Noise**
  - Low noise (SPB)

- **Constructability**
  - Field trials

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- Literature Review
- Workshop
- Laboratory Design
- Demonstration Trial
- Field Trial
The Journey

- Literature Review (2015)
- Workshop (2015)
- Laboratory Design (2016)
- Demonstration Trial (2016)
- Field Trial (2017, 2018)
What next?

PASS with different aggregate, binder and laying contractor

Development and Assessment of PASS

Development of New ‘Inspection Panel’

Digitisation Auto-QA

Launch Event
Findings and reports from these projects can be found at Highways England’s Knowledge Compendium (http://www.highways.gov.uk/knowledge/), as well as AECOM microsite (http://www.aecom.com/uk/pavement-design-publications/)
Thank You

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