Greener, Leaner and Meaner

How a number of innovations in pavement design and installation saved time, cost and materials on the A45 Weston Favell - Billing trunk road, Northamptonshire.

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Picture 1 – A45 Billing - The finished project

Introduction:

The Highways Agency, ever on the look out for cost effective solutions to highway maintenance issues, installed a highly innovative combination of surfacing treatments on the A45 Billing trunk road last summer. The resulting benefits included time, materials and cost savings, as well as improved bearing capacity.

This was achieved by:

a) Leaving in damaged yet structurally significant concrete bays.
b) Incorporating a minimum 10 year pavement design against reflective cracking.
c) Improving longitudinal asphalt paving joints
d) Providing a highly durable, low fatigue, skid resistant surfacing.

The contract was completed in 5 weekends, 3 less than the original conventional design proposal.

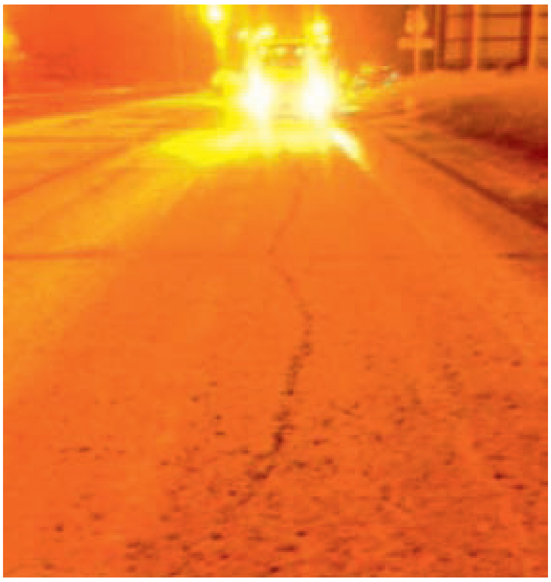
This article details an innovative thin pavement design which utilises a combination of asphalt reinforcement and polymer modified asphalt surfacing which has also eliminated the requirement to remove and replace damaged concrete slabs, or lift barriers and kerbs.

Pavement condition and the client's requirements.

The original reinforced concrete pavement had been overlaid seven years earlier with a Safepave® thin surfacing layer. This was showing signs of ravelling and stripping particularly around the joints which had been extensively patched and filled. The concrete slabs were showing visible signs of movement and longitudinal cracks were present in some areas.

Picture 2 – Highway prior to treatment (right side) and during overlay (left side)

Conventional maintenance for this type of construction would suggest breaking out of the damaged and rocking concrete bays; digging out of the foundations; reinstating and adequate



Picture 3 – Longitudinal cracks revealed after night time removal of Safepave® and 20mm of concrete surface.

compaction of foundation layers and casting concrete with the inherent curing time that involves. In addition, overlaying the concrete with asphalt would require a thickness of around 240mm to ensure reflective cracking did not reoccur during the period to next treatment. This thickness of overlay was not going to be possible given the limits to headroom under the two overbridges on the site.

The Highways Agency therefore worked with Carillion URS, Lafarge framework contractors on this Area 8 MAC contract, Ooms International and sub contractor to Lafarge, Asphalt Reinforcement Services to design a suitable alternative with the following criteria:

- Shorten the eight weekend program to five by not removing the damaged concrete bays.
- Provide a design life for a 95% crack free surfacing of more than 10 years, i.e. the expected minimum lifetime of the surfacing.
- Provide texture depth and skid resistance to HA requirements.
- Provide a durable long life surfacing not prone to ravelling or loss of texture with a total thickness of a maximum of 50mm over current concrete levels.

Analysing the existing pavement and designing a solution.

In order to ascertain the viability of leaving the damaged concrete slabs in place, Ooms worked with TRL to analyse movements and load transfer

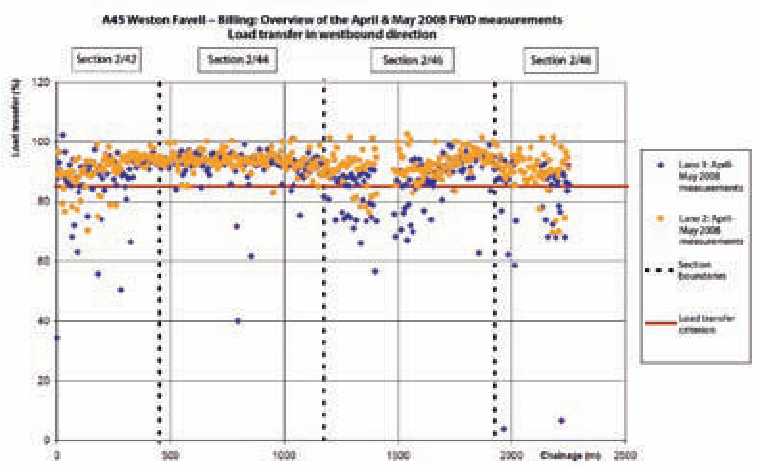


Diagram 1 – FWD measurements, load transfer west bound

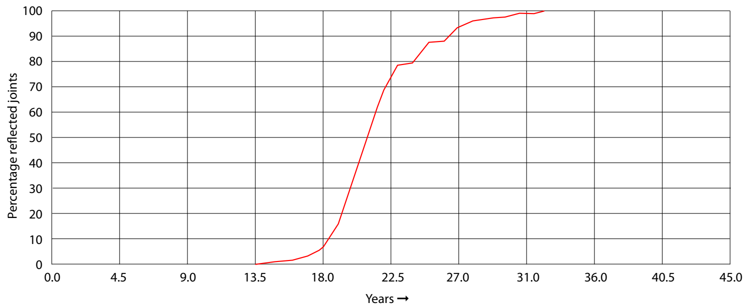


Diagram 2 – Expected % reflective cracking performance versus years in service

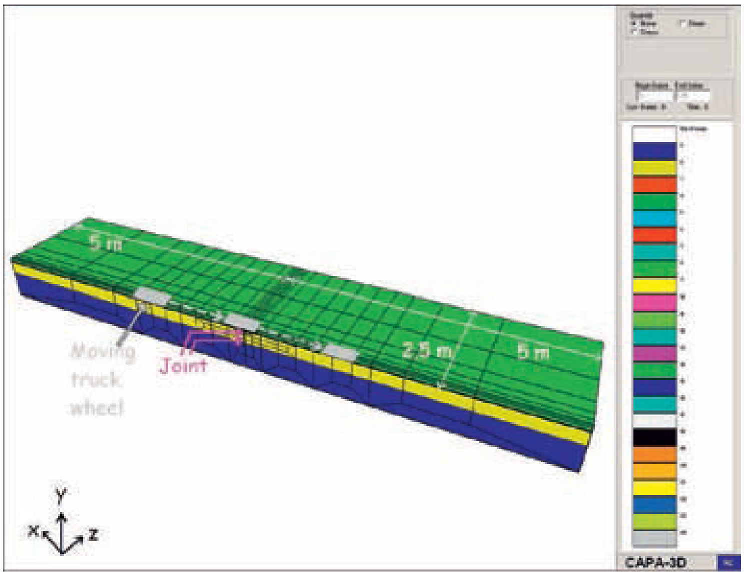


Diagram 3 – Finite element analysis mesh used for the A45.

on the over 200 or so 5m bays and longitudinal cracks along the project. These complex finite element analysis calculations had two criteria for stage 1 treatment. (See *Diagrams 1&3*, previous page.)

1. At least 85% load transfer at joints was required.
2. Relative vertical movement between adjacent joints must be less than 50µm.

Where these criteria were not met additional stage 2 measures were deemed to be required in the form of a "Detailed Repair System" designed specifically for this project as described later in this paper.

Final design prior to trials

The proposed design was finalised and a departure to standard issued by the HA after consultation with Lafarge and its subcontractor Asphalt Reinforcement Services who installed the GlasGrid®, CompoGrid® and Sealoflex® SC-4 spray systems.

The final pavement structure was as follows:

- Plane off existing Safepave® and 20mm into the concrete surfacing.
- Thoroughly clean and tack coat the prepared concrete.
- Install stage 2 "Detailed Repair System" where required centred on joints or cracks being treated.
- Lay 20mm regulating course over the entire area.
- Onto the regulating install 56,000m^2 of GridSeal® i.e. GlasGrid®8501 with 2.0kg/m^2 Sealoflex® SC-4 hot bitumen spray with 7kg/m^2 10mm chippings to cover 50% of the area of binder.
- Overlay with 50mm Sealoflex® SFB5-50 (HT) 0/14 SMA surface course.

Pre-contract trials

Due to the innovative nature of the proposed design, pre contract trials took place at Lafarge Mount Sorrel production plant monitored by all parties. The trials were designed to determine if the Sealoflex® SMA mix design could be mixed, laid and compacted to the requirements of the client, Carillion URS, Lafarge and Ooms International while still maintaining texture depth of minimum 1.5mm to UK requirements. Texture depth requirements are not seen in The Netherlands where similar materials are in widespread use but are laid to compaction criteria for durability instead.

The Ooms mix design was produced in accordance with BSEN13108-5 based on UK and EU SMA experience and incorporating 6.1% of Sealoflex® SFB5-50 (HT) capable of withstanding both permanent deformation and cracking including at high and low temperature extremes. Sealoflex® has been used extensively in Europe and worldwide for 20 years but this was its first use in hot mix asphalt in the UK.

A rolling pattern was designed to ensure the required compaction without fatting up and the Sealoflex® modified SMA was travelled for 2 hours to simulate possible travel time on the job. For the first time in the UK a ceramic joint heater attached to the paver was used to close cold joints on the centre line. The installation of the GridSeal® GlasGrid® 8501 plus Sealoflex® SC-4 spray and chippings was also checked during the trials. Wheel tracking, core density and other parameters were also measured from cores taken.

Following the trials, the decision was made to go forward with the scheme and the work started on site on the weekend of 30th May 2008.

Project details and best practice on site

With supervisory assistance from Ooms International and its UK representatives Material Edge, the contract was successfully completed in five weekends. PTS International provided supervision on rolling patterns as well as coring, density testing and texture depth measurements.

Some elements were more difficult than first thought and some were more straightforward. The following is a list of key events and lessons learned during the project.

1. For the modified SMA surface course Ooms require a degree of compaction measurement of >97% of the reference Marshall density achieved in the laboratory. This is further calibrated on site from on going core bulk density results. This differed from the UK method of controlling compaction through monitoring of texture depth and although thought to be difficult to achieve it was in practise much easier than expected and will result in improved durability of the finished surfacing layer.
2. The storage stability of the Sealoflex® SFB5-50 (HT) in both the coating plant and in the SMA during travelling and laying was noted as considerably better than other PMB's used by the contractor. A maximum of 14 hours storage of the mixed SMA at the plant or in transit was easily maintained. No binder drainage was seen on any of the deliveries.
3. Some fatting up was seen due to over-rolling. This was eliminated by keeping rollers off the mat when it was still very hot (>170°C) and increasing the length of rolling sections to avoid

Picture 4 – Final texture at >97% compaction.

repeatedly traversing certain areas. The roller pattern in Diagram 4 explains this process.

4. Paving speeds are lower in Continental Europe than in the UK as more compaction is required from the vibrating screed plate and less from rolling. Ooms instructed that paving of the surface course take place at 5m/minute therefore which when coupled with a continuous supply of material and no stopping of the paver provides a better ride quality and greater durability in service. Additionally the width of the screed opening was limited to 80% of maximum to ensure even and adequate compaction.

   Compaction of Sealoflex® modified SMA requires special attention to eliminate the bounce back effect seen when compacting highly elastic, high quality SBS Polymer Modified Binders (PMB's). *Diagram 4* shows this effect. Rolling was therefore continued until the material reached an internal temperature of 60°C.

5. The installation of the Detailed Repair System with 20mm of regulating course over it was more difficult to achieve than expected. The conditions needed to ensure success were not always available and dust and moisture on the surface of the milled concrete sometimes resulted in either the tack coat failing under site traffic or the SC-4 and CG200 being pushed by the paver or roller. With careful monitoring it was possible to install this system but recommendations for subsequent installations will include a thicker regulating course. Installation was at the rate of 10 repairs per hour, full carriageway width.

6. The installation of GridSeal® 8501 over the regulating course was a great success and outputs of 4,000m²/hr with a maximum 6,200m²/hr were achieved. During wet weather a pre heater was applied to the surface when required.

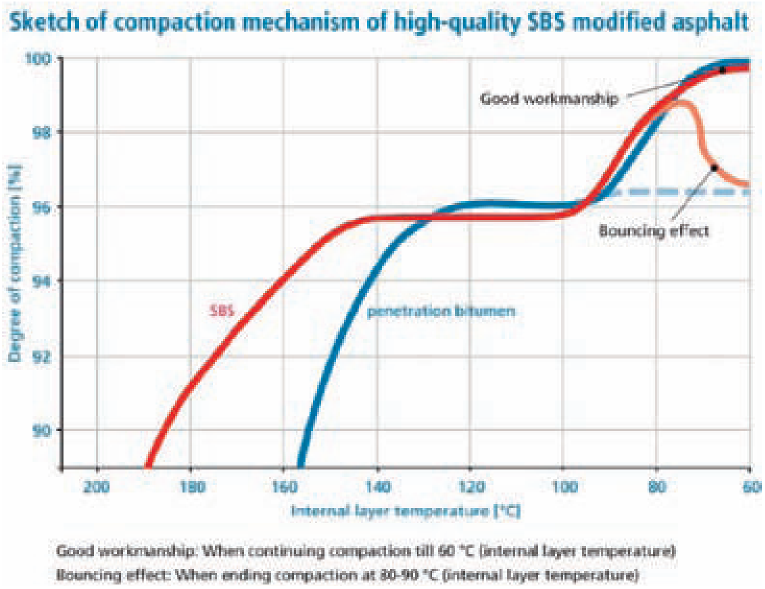


Diagram 4 – Compaction of high quality SBS PMB's

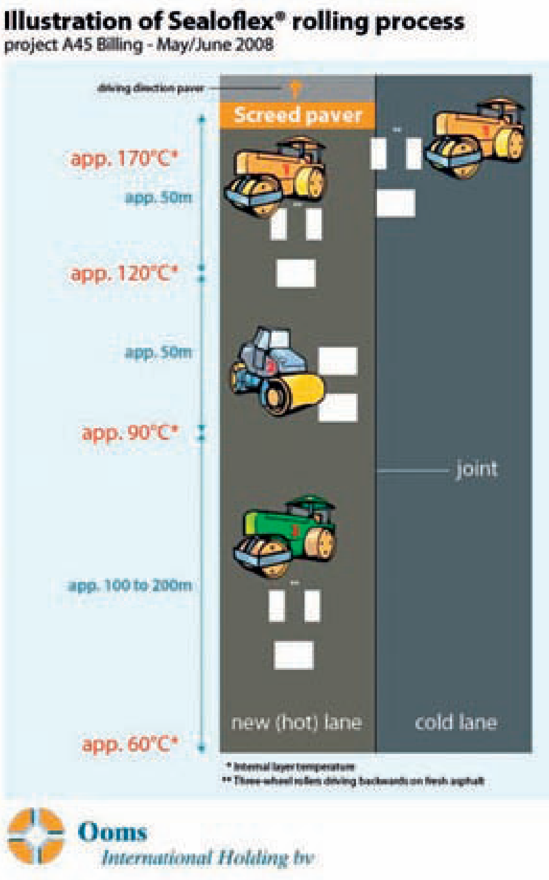


Diagram 5 – Sealoflex® rolling pattern diagram

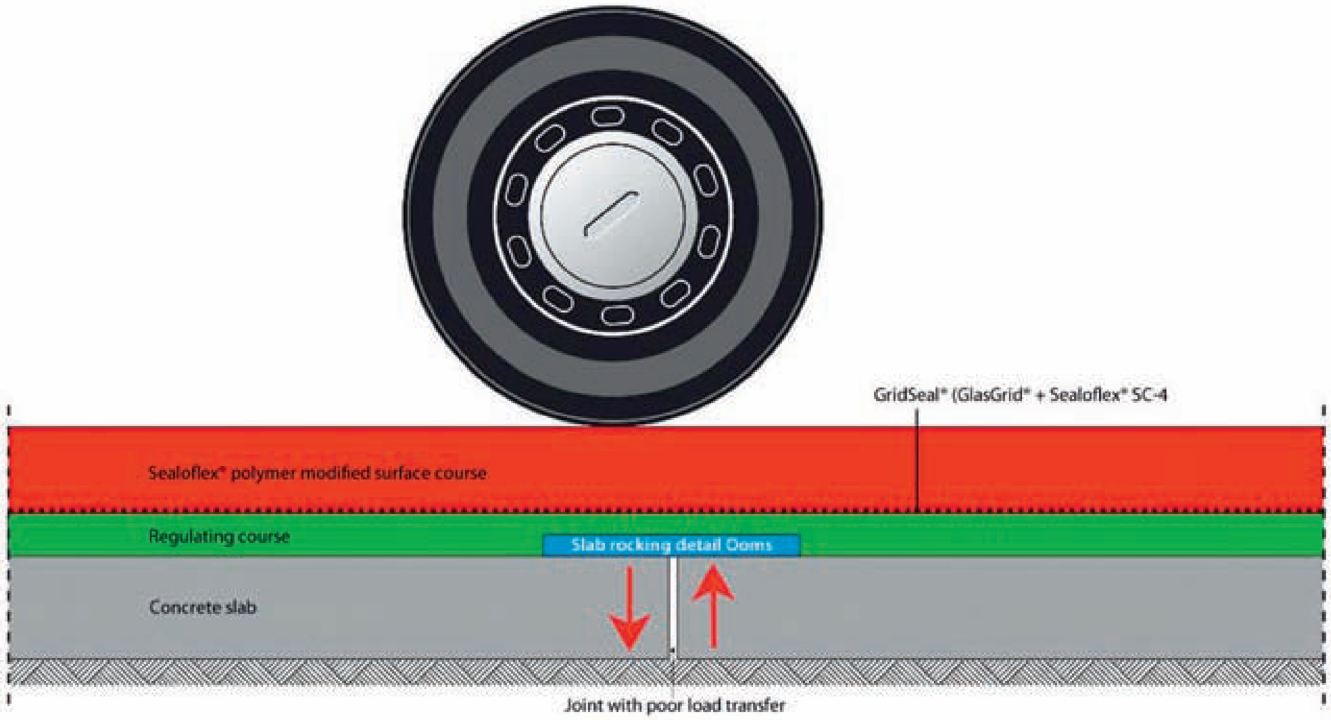
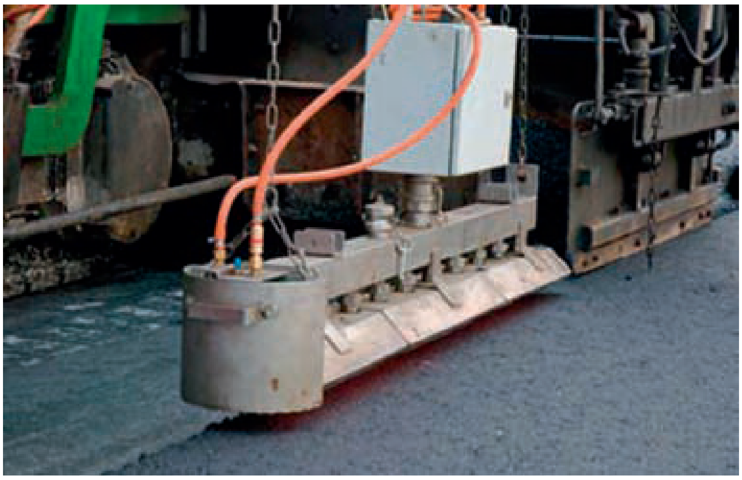


Diagram 6 – Detailed Repair System instructions

Experience with a joint heater

Due to the inherent elasticity of Sealoflex® modified surfacings after laying and cooling, it is even more critical that longitudinal construction joints in the paved mat are hot jointed, either by paving in echelon or with the use of a joint heater.

As a running lane was required for emergency vehicles throughout the contract period, it was not possible to utilise pavers in echelon. Another first therefore was the use of an Ecoseam ceramic joint heater provided by Material Edge which increased the temperature of the cold mat joint to about 110°C prior to paving and rolling in the hot mat alongside. This has provided very tight and almost invisible joints which will be as durable as the rest of the mat and not a future weak spot for ravelling and water penetration as can often be the case. Invisible joint lines also improve safety for traffic driving in poor visibility and at night when joints are sometimes mistaken for traffic demarcation lines.



Picture 5 – Material Edge, Ecoseam Joint Heater in use.

Observations after the first winter

A visual inspection was made at the end of April during which some cracking was observed particularly in the "control" test sections without the GridSeal® and Sealoflex®. These are recorded in table 1.

Summary of observations:

6 cracks in 1600-1700 "control" test section with No GridSeal.

1 crack in 1700–1800 "control" test section + GridSeal at start of section 1710m.

3 cracks one with possible pumping in 1900-2000 "control" test section with No GridSeal, thought to be 5m from a detailed repair.

1 possible undefined crack in 2000-2100 SMA regulating + Sealoflex + GridSeal - Main scheme treatment.

Conclusions

The A45 Weston Favell to Billing trunk road project was highly innovative and incorporated a number of novelties to the UK trunk road network. The results of this major trial are being closely monitored by TRL for the Highways Agency.

Early signs are that the use of the Sealoflex®

Chainage	Total chainage + Recorded Surfacing	Crack type	Comment
1600-1700m	1600-1700 "control" test section (No GridSeal)	4 Hairline wandering cracks	Wheel tracks mainly, not well defined cracking.
1623m	1600-1700 "control" test sections (No GridSeal)	Hairline wandering cracks	Wheel tracks mainly quite well defined
1645m	1600-1700 "control" test sections (No GridSeal)	Hairline wandering cracks	Wheel tracks mainly quite well defined
1710m	1700-1800 "Control" test sections + GridSeal	Hairline linear crack in wheel tracks only	GridSeal recorded starts 1700, check against records
1925m	1900 – 2000 "Control" test section (No GridSeal)	Linear well defined crack	
1945m	1900 – 2000 "Control" test section (No GridSeal)	0.5m linear well defined crack with evidence of pumping (fines at surface)	Detailed repair recorded at 1940m none at 1945m
1950m	1900 – 2000 "Control" test section (No GridSeal)	Hairline wandering cracks	
2070m	2000 – 2100 SMA Reg + GridSeal + Sealoflex SMA	Possible undefined hairline cracks?	Core patches seen at 2150m

Table 1 – A45 Visual inspection 29th April 2009

Picture 6 – Typical "control test section cracking after first winter

Picture 7 – Typical "control" test section cracking with evidence of possible pumping after first winter

polymer modified SMA with GridSeal® reinforcement inter layer is performing better than the smaller "control" test sections. As the majority of the scheme incorporates the former combination, the original design is performing to the expectations of the designers and the client.