A history of the recent thin surfacing revolution in the United Kingdom

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Executive Summary

Thin surfacing systems are defined as proprietary bituminous mixtures that can be laid at nominal thickness of less than 40 mm. For most of the latter half of the twentieth century, most asphalt surfacing was carried out at nominal thicknesses of 40 mm or greater in hot rolled asphalt or dense bitumen macadam. There were surfacings that could be laid at lesser thicknesses but none were widely used. Neither were many of these early thin surfaces proprietary.

In 1991, the first of the proprietary thin surfacing systems developed in France was introduced into the United Kingdom with a second the following year. Trials of these first two systems plus generic Stone Mastic Asphalt (SMA) (introduced in 1994) were monitored on behalf of the Highways Agency whilst subsequent thin surfacings, including those based on SMA, were monitored on behalf of the relevant supplier. From these trials and later ones, thin surfacing systems were accepted as a surfacing that now provides the majority of material used in the UK.

Initially, the proprietary products were approved by the Highways Agency with 21 systems gaining such approval. This approval only demonstrated the systems could work, with no quality assurance to confirm the relevant standard is routinely maintained. Therefore, a more complete system under the British Board of Agrément was set up with the first BBA-HAPAS certificates being issued in 2001. However, thin surfacings as proprietary products may develop further into generic materials with the expected introduction of CEN standards for thin asphalt concrete and Stone Mastic Asphalt.

The paper reviews this change in surfacings for road pavements, both in the historical developments and the technical implications. The technical implications include both the number of performance parameters that are required, which has increased, and the methods of specifying, which has changed.

The paper was first published by the Institution of Asphalt Technology in ‘The Asphalt Yearbook 2001’, when it was awarded the annual Argent Award for the best paper. The paper has been updated slightly.
1 Introduction

The use of proprietary thin surfacing materials as the surface course on UK roads has increased dramatically from their introduction nearly a decade ago to becoming the most commonly used option. Ten years ago, proprietary materials were only specified when there was no viable option, now they are the preferred choice of many specifying bodies. This paper reviews the history that has lead to these changes in both material use and the perception of how to purchase them.

However, before the history of thin surfacings can be reviewed, a definition of a thin surfacing is required. For this purpose, the definition used for the British Board of Agrément’s Highway Authorities Product Approval Scheme (BBA-HAPAS) (BBA, 2000) is appropriate. Their definition is ‘a proprietary bituminous product with suitable properties to provide a surface course that is laid at a nominal depth of less than 40 mm’. Therefore, thin surfacing systems are of an intermediate thickness between veneer coats (such as surface dressings, slurry surfacings and high-friction surfacings) and surface course materials laid at the more traditional thicknesses between 40 mm and 50 mm (such as hot rolled asphalt and coated macadam). Furthermore, hot rolled asphalt, macadam, slurry surfacings and surface dressings are not excluded if they are laid at nominal thicknesses less than 40 mm provided that someone wishes to promote them as their proprietary material.

Because the definition of thin surface course materials, or thin surfacings, is very wide, they can be categorised in several ways. However, the simplest approach is to consider the material type from which they were developed. In this way, the categories currently available (Laws, 1998) are:

- Thick slurry surfacing.
- Multiple surface dressing.
- Paver-laid surface dressing.
- Thin polymer-modified asphalt concrete.
- Thin Stone Mastic Asphalt (SMA).

2 Early materials

Prior to the introduction of the first of the current thin surfacings in the early 1990s, not every surface course layer was laid at a nominal thickness of at least 40 mm. The standards of a quarter of a century earlier had included mixtures for use at lesser thicknesses. In particular, the 1961 specification for hot rolled asphalt (BSI, 1961) included a category for ‘thin wearing course mixtures containing 30 – 55 % coarse aggregate’ to be laid 20 mm – 30 mm thick.

At the time that the current thin surfacing systems started to appear here, the thin surface course materials laid in the United Kingdom were restricted to (Laws, 1998):

- coated macadams of generally 10 mm nominal size and below, including fine cold asphalt (which is neither laid cold nor is an asphalt in terms of the more restricted definition then used) to BS 4987 (BSI, 1992); or
- sand-carpet type hot rolled asphalts to BS 594 (BSI, 1993); or, less commonly
- dense tar surfacing; or
- mastic asphalt.

These materials do not fully comply with the definition of thin surfacings because they are not proprietary products. However, they could become so if producers considered it worthwhile to give their versions of them proprietary names. Hence, there has been the potential to develop proprietary thin surfacings even before the various mixture designs were introduced from abroad, in particular from France and Germany, as described below.

3 French very thin and ultra thin materials

In France, thin surfacing technology was developing during the 1980s through the use of a better understanding of the rheology of modified binders that came about with the availability of test equipment such as the dynamic stress rheometer. The mixtures were initially introduced through the *Avis Technique* (or ‘technical opinion’) system whereby a group of experts from various areas of the industry set out their view the material based on a set of test results. The *Avis Technique* allows the material to be used within the limits set out within the document until a national specification is produced.

The initial materials were thin polymer-modified asphalts, originally designed to be maintenance treatments but subsequently used in new construction. One of these products is called a ‘very thin surface layer’ (VTSL) in France but are termed an ‘asphalt concrete for very thin layers’ in the proposed harmonised CEN specification (CEN, 2000a). Several terms are used in the United Kingdom, but the most descriptive is ‘thin polymer-modified asphalt concrete’. VTSLs were developed from asphalt concrete but are now distinct because they are gap-graded mixtures with, usually, a nominal 10 mm size coarse aggregate and a modified binder. The material is bonded to the road surface by prior application of a tack-coat sprayed at a rate of between 0.7 l/m² and 1.75 l/m², depending on the system and the porosity of the substrate. Most of the major material suppliers in France had their own system, and a national specification (AFNor, 1992) was introduced for them.

A extension in the concept of thin surfacings was the ‘ultra thin hot mix asphalt layer’ (UTHMAL). UTHMAL was originally proposed as a process that would not have the drawbacks associated with surface dressing and it may be considered as a paver-laid hot mix surface dressing. Laboratoire Central des Ponts et Chaussées (LCPC) in conjunction with SCREG Routes developed the original UTHMAL, *Euroduit*, which is the only one marketed in France. As such, a national specification has not been produced for the material. The material is a hot bituminous...
mixture spread directly over a sprayed binder film by a
purpose built machine (Figure 1) that incorporates a binder
sprayer and material distribution system to lay the mixed
material. The long length of the machine enables an
excellent longitudinal profile to be achieved. The sprayed
binder is a modified emulsion, containing approximately
70% solids, and it is applied at a rate of 1 l/m². The mixed
material is almost single sized with some fines and,
usually, an unmodified binder such as 100 pen bitumen.

SCREG Routes renamed Euroduit as Novachip for
franchising its use outside France. In 1991, Associated
Asphalt took the franchise for the United Kingdom but under
a third name, Safepave, after taking a small group of UK
specifiers to France to see the potential of, and persuade them
to provide trial sites for, the product. The trip worked, and the
first British sites were laid with Safepave later that year when
the specialist machine was brought over to the United
Kingdom (Figure 2). The mixed material specification was
originally to the French design, although it was subsequently
modified to make it more specific for the British market. The
aggregates used are of a high quality and high polished stone
value in order to achieve a good skid-resistance.

The following year, Alfred McAlpine took a similar
party to see the VTSL developed by Enterprise Jean
Lefebvre, UL-M. The bitumen is either a 70 pen or
100 pen, modified with an ethylene vinyl acetate co-
polymer, at a binder content within the range 4.5% to
7.0%, depending on the mixture. UL-M, manufactured
using conventional equipment and laid to the French
specification, was introduced into the United Kingdom in
1992 by Alfred McAlpine but was subsequently sub-
licensed to several UK asphalt producers.

The early systems were monitored as trials by TRL on
behalf of the Highways Agency to determine their
suitability for UK conditions, in particular the
requirements for skid-resistance and texture depth on high-
speed trunk roads. These trials proved successful (Nicholls
et al., 1995; Nicholls, 1998a) and the initial two thin
surfacing systems were approved by the Highways Agency
for use on the trunk road network through a new
specification clause, now included as Clause 942 in the
Specification for Highway Works (MCHW 1).

4 German Stone Mastic Asphalt

An alternative mixture for thin surfacings to that
developed in France is Stone Mastic Asphalt. Stone Mastic
Asphalt (SMA) (Bellin, 1992; Bellin, 1998; Nunn, 1994;
Loveday & Bellin, 1998) was developed in Germany over
20 years ago as a deformation-resistant material, originally
to offset the problem of wear from studded tyres. The
material was conceived as a compromise between
gussasphalt and asphalt concrete and proved so useful that
it was retained even when the problem was overcome
simply by banning the use of studded tyres. The aggregate
grading in SMA is similar to that of porous asphalt, but
with the voids filled with mortar. SMA is generally used as
a full-depth surfacing material in continental Europe, but it
can be used at reduced thicknesses as a thin surfacing.

SMA was among the European asphalt products that
were investigated as part of the joint research carried out
by TRL for the Highways Agency, Quarry Products
Association and Refined Bitumen Association. In 1994, a
party with representative from across the industry visited
Germany and, on their return, organised two trials, one at
RAF Lakenheath and one at TRL. As an appendix to the
report on the investigation (Nunn, 1994), a provisional
specification was provided for SMA as a generic material. Based on this specification, road trials were monitored by TRL on behalf of the Highways Agency (Figure 3).

Thin surfacings systems that have been laid on local authority roads, or as trials on trunk roads, generally have sufficient supporting evidence to demonstrate their compliance with Stages 1, 2 and 3. Stage 5 is unnecessary for thin surfacings because the specification is already available. Therefore, it is the position with regard to the Stage 4 Full-Scale Trials (Figures 4, 5 and 6) that needs to be assessed for each additional system. The main points that need to be demonstrated in order for the material to comply with this stage are:

- The thin surfacing can be laid successfully with all the properties required of any wearing course (texture depth, profile, lack of surface defects, etc., as set out in the Specification for Highway Works (MCHW 1)).
- The thin surfacing can achieve a skid-resistance value, as measured by SCRIM, above the relevant investigatory level.
- The thin surfacing can maintain a texture depth of at least 1.0 mm and a skid-resistance above the relevant investigatory level after two years in service with a traffic flow of at least 1,000 commercial vehicles per lane per day, but preferably at least 2,000 cv/l/d. (Any approval granted based on trials on roads carrying less than 1,000 cv/l/d is limited to use on roads up to a stated maximum traffic flow).

Other data on the thin surfacing system will also be useful in obtaining an overall assessment of the material.

At the time of writing, the systems with approval are given in Table 1. Reports on four of the materials, Axoflex (Nicholls, 1997), Millom Hitex (Nicholls, 1998b), Thinpave (Nicholls, 2000a) and Smatex (Nicholls, 2000b), have been published.

5 Highways Agency approvals

As noted above, the original clause in the Specification for Highway Works (MCHW 1) for thin surfacing systems was written around two products, the first two marketed in this country. The draft clause relied on the evidence from the trials that these two materials could be produced and laid satisfactorily and, as such, was based around proprietary products that had gained approval. In order not to give an unfair advantage to the two products, there had to be a means by which other thin surfacing systems could gain approval.

In addition, there was also a need to consider thin SMA systems and whether to introduce a generic clause for SMA or whether to encourage their use as proprietary thin surfacings. Two advantages of the approvals approach used for thin surfacings are the freedom it allows contractors to develop mixtures appropriate to the component materials available to them and the inclusion of a two year warranty period (although contractors make remedials even after that period in order to protect ‘their’ product). Therefore, the Highways Agency decided to treat thin SMA as a category of thin surfacing.

The Highways Agency has a five-stage procedure for evaluating new materials that could be applied to thin surfacings. The five stages are a desk study, a laboratory study, pilot-scale trials, full-scale trials and specification trials. The first four stages can be carried out by any suitable body on behalf of the promoter of the new material; however, the Highways Agency requires that TRL evaluate the results in order to assess the stage that has been reached and advises them accordingly. The final stage is carried out by the Highways Agency to ensure that there is an appropriate means of specifying the product(s) for contractual use. The Highways Agency will give approval to use a material when they are satisfied that all stages have been successfully completed.
For English trunk roads, the Highways Agency is both the specifying and approving body, which could lead to a conflict of interests.

The scheme checks to show that a system can be produced and laid satisfactorily, not that it will be routinely delivered to an appropriate standard.

Furthermore, since the introduction of thin surfacings to the United Kingdom, they had gone from a speciality product to the most commonly used surface course material, and therefore warranted specifying in greater detail.

A more universal certification scheme was introduced for thin surfacings (Nicholls, 2000c), including aspects of quality assurance, by the British Board of Agrément (BBA) with the support of the Highways Agency, the other UK Overseeing Organisations, the CSS and industry. The scheme for thin surfacings is part of the *Highway Authorities Products Approval Scheme* (HAPAS), the guidelines for which (BBA, 2000) have been agreed.

The first BBA-HAPAS certificate was issued in February 2001 and the proprietors of all the other systems with Highways Agency approval for use on trunk roads are understood to be working towards gaining certification. Clause 942 of the 2001 revision of the *Specification for Highway Works* (MCHW 1) require all thin surfacings to be used on trunk roads to have BBA-HAPAS certificates after January 2002. By October 2001, BBA-HAPAS certificates had been issued covering 11 thin surfacing systems and these are listed in Table 2.

### Table 2 Thin surfacing systems with BBA-HAPAS certificates*

<table>
<thead>
<tr>
<th>Certificate no.</th>
<th>System(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>00/H042</td>
<td>Masterflex</td>
</tr>
<tr>
<td>01/H047</td>
<td>UL-M</td>
</tr>
<tr>
<td>01/H048</td>
<td>Hitex                Thinpave Smatex</td>
</tr>
<tr>
<td>01/H050</td>
<td>Masterphalt-P</td>
</tr>
<tr>
<td>01/H051</td>
<td>Viatext</td>
</tr>
<tr>
<td>01/H052</td>
<td>Masterpave</td>
</tr>
<tr>
<td>01/H054</td>
<td>Premier Pave</td>
</tr>
<tr>
<td>01/H055</td>
<td>Tuffgrip</td>
</tr>
<tr>
<td>01/H056</td>
<td>Masterphalt-F</td>
</tr>
</tbody>
</table>

* As at 28/11/01

### Table 1 Highways Agency approved thin surfacing systems

<table>
<thead>
<tr>
<th>Paver-laid surface dressing</th>
<th>Thin asphalt concrete</th>
<th>Thin Stone Mastic Asphalt</th>
<th>Multiple surface dressing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>System</strong></td>
<td><strong>Supplier</strong></td>
<td><strong>System</strong></td>
<td><strong>Supplier</strong></td>
</tr>
<tr>
<td>Safepave</td>
<td>Associated Asphalt</td>
<td>Masterpave</td>
<td>Tarmac</td>
</tr>
<tr>
<td>UL-M</td>
<td>Lefèvre licensees</td>
<td>Axofibre</td>
<td>Lafarge Aggregates</td>
</tr>
<tr>
<td>Hitex</td>
<td>Aggregate Industries</td>
<td>Viatex</td>
<td>RMC Aggregates</td>
</tr>
<tr>
<td>Axoflex</td>
<td>Lafarge Aggregates</td>
<td>Smatex</td>
<td>Aggregate Industries</td>
</tr>
<tr>
<td>Tuffgrip</td>
<td>Hanson</td>
<td>Steelpave</td>
<td>Slag Reduction</td>
</tr>
<tr>
<td>Colrug</td>
<td>Colas</td>
<td>Nashpave</td>
<td>Tarmac</td>
</tr>
<tr>
<td>Thinpave</td>
<td>Aggregate Industries</td>
<td>Premier Pave</td>
<td>Foster Yeoman</td>
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<tr>
<td>Viapave</td>
<td>RMC Aggregates</td>
<td>Masterpave</td>
<td>Tarmac licensees</td>
</tr>
<tr>
<td>Masterflex</td>
<td>Tarmac</td>
<td>Smartpave</td>
<td>Hanson</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Duratex F</td>
<td>Tarmac</td>
</tr>
</tbody>
</table>
The assessment of systems will be based on laboratory testing, a system installation trial and at least three 2-year system performance trials of which one has been fully monitored. The system installation trial can also be used as a performance trial, and data relating to trials carried out for Highways Agency approval can be used where applicable. Some of the properties are optional and will only be included in the assessment by BBA at the request of the applicant. The tests that are used are given in Table 3. It is intended that the variety of performance measures will allow specifiers to identify those that are relevant to their particular job and include appropriate requirements, not to specify the highest category for every conceivable property ‘just in case’.

7 Future developments

BBA-HAPAS certification will soon be the routine method for specifying thin surfacings for use on UK roads as proprietary systems. However, towards the middle of this decade, the package of harmonised European standards for asphalt materials and associated tests should be implemented. Implementation implies that the British Standards Institution will have to publish them, replacing any existing standards that cover the same subject. The package includes prEN 13108-2, Asphalt concrete for very thin layers (CEN, 2000a), and prEN 13108-5, Stone Mastic Asphalt (CEN, 2000b). Therefore, from that time, there should be generic specifications that will cover these materials.

8 Concluding remarks

Thin surfacings, including Stone Mastic Asphalt, are generally less expensive than conventional hot rolled asphalt but more expensive than surface dressing. They can be laid at a faster rate than hot rolled asphalt and do not require the high degree of aftercare needed for conventional surface dressing. Use of the materials is also less disruptive to traffic because the new surface can be put into service soon after laying. Although the materials have not been in service for sufficient time to fully assess their durability, they can provide an effective regulating layer, improve evenness and give a good standard of surface finish and riding quality with good skid-resistance and are capable of producing initial texture depths above the 1.5 mm sand-patch value required for UK high-speed roads. In addition, their spray and noise reducing properties are at least as good as, and generally better than, conventional hot rolled asphalt and surface dressing. As such, the materials are gaining an increasing share of the UK market and are approved for use by most major specifiers.

9 Acknowledgements

This paper was prepared in the Infrastructure Division of the TRL Limited. The paper was first published by the Institution of Asphalt Technology in ‘The Asphalt Yearbook 2001’, when it was awarded the annual Argent Award for the best paper. The paper has subsequently been updated.

10 References


Table 3 Tests for BBA-HAPAS Approval

<table>
<thead>
<tr>
<th>Status</th>
<th>Location</th>
<th>Parameter</th>
<th>Test</th>
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<tbody>
<tr>
<td>Mandatory</td>
<td>Laboratory</td>
<td>Skid Resistance</td>
<td>Polished stone value of the aggregate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Resistance to abrasion</td>
<td>Aggregate abrasion value</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Deformation resistance (@ 45°C and/or 60°C)</td>
<td>Wheel-tracking rate. Depth of rutting</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Shear strength</td>
<td>Torque bond test</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sensitivity to water</td>
<td>Retained stiffness after immersion</td>
</tr>
<tr>
<td>Road</td>
<td></td>
<td>Visual condition</td>
<td>Initial and after 2 years</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Texture Depth</td>
<td>Initial and after 2 years</td>
</tr>
<tr>
<td>Optional</td>
<td>Laboratory</td>
<td>Stiffness</td>
<td>Indirect tensile stiffness modulus</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sensitivity to diesel (or other fluids)</td>
<td>Retained stiffness after immersion</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ageing characteristics</td>
<td>Fatigue test before and after ageing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Resistance to stripping</td>
<td>Immersion wheel-tracking test</td>
</tr>
<tr>
<td>Road</td>
<td></td>
<td>Noise</td>
<td>Statistical pass-by</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Improvement in regularity</td>
<td>Change in longitudinal evenness</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Spray reduction</td>
<td>Change in transverse evenness</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Enhanced skid resistance</td>
<td>Relative hydraulic conductivity</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>SCRIM within 12 weeks of laying MSSC during second summer</td>
</tr>
</tbody>
</table>


Abstract

The report reviews the major changes that have occurred in the surface course materials used in the United Kingdom during the 1990s. Until the mid-1990s, most asphalt surfacing was carried out at nominal thicknesses of 40 mm or greater in hot rolled asphalt or dense bitumen macadam. Prior to that, there had been surfacings that could be laid at lesser thicknesses but none were widely used. In 1991, trials of French thin surfacings were started whilst SMA trials started from 1994. From these trials and later ones, thin surfacing systems were accepted as a surfacing that now provides the majority of material used in the UK. Initially, the proprietary products were approved by the Highways Agency but this is being superseded by BBA-HAPAS certification. The products may develop further into generic materials with the expected introduction of CEN standards for thin asphalt concrete and Stone Mastic Asphalt.

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Related publications

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TRL314  Road trials of Stone Mastic Asphalt and other thin surfacings by J C Nicholls. 1998 (price £35, code H)
TRL292  Assessment of MILLOM HITEX, the Bardon thin asphalt surface course. 1998 (price £20, code C)
TRL218  Assessment of AXOFLEX, the Redland thin asphalt surface course by J C Nicholls. 1997 (price £25, code E)
PR79   Road trials of thin wearing course materials by J C Nicholls, J F Potter, J Carswell and P Langdale. 1995 (price £35, code H)
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