Abstract

Against a backdrop of reduced public expenditure by the UK government over the next few years, highway authorities and their contractors need to devise new strategies for maintaining the existing highway asset by in essence doing more with less. There is expected to be significant cut backs with respect to capital projects and structural maintenance which should result in placing greater emphasis on the use of surface treatments such as Surface Dressing, Slurry-Micro Surfacing, High Friction Surfacing, Re-Texturing and other perhaps less well known but equally proven and important techniques. Traditionally the use of surface treatments has been seen by some practitioners to be a marginal activity, a fix and mend approach, however with the changing landscape of reducing highway budgets surface treatments will need to step out of the margins into mainstream thinking and become integrated into asset management planning. This paper reviews the various techniques now on offer in terms of features, benefits, applications and durability.

The Road Surface Treatments Association represents nearly 70 companies, ranging from multi nationals to regional players with a combined members annual turnover of around £1Bn. It was formed in 2008 following the merger of the Road Surface Dressing Association (RSDA), The Slurry Surfacing Contractors Association (SSCA), High Friction Surfacing Association (HFSA) and Allied Industry members.

Further information on our range of membership services and activities can be found on the RSTA website at www.rsta-uk.org plus details of all the various treatments, how they work and where they can be used.
Introduction

Before local authorities examine the option of cutting back maintenance expenditure on their road networks they should consider that Britain’s crumbling roads are costing the national economy some £20 billion every year and cost councils an annual £53 million in compensation claims.

It is the poor condition of local roads that is most noticed by road users. A report from the RAC found that 89% of its members are ‘frustrated’ at the condition of their local A and B roads with only 2% believing that local roads are adequately maintained. Motorists pay £46 billion a year in taxes but just £2.7 billion of that is spent on road maintenance. Meanwhile, it is estimated by the Asphalt Industry Alliance that there is a pothole every 120 yards and that the cost to carry out the necessary repairs is some £8.5 billion.

“Councils are under pressure to cut back expenditure and they often look at cutting the highways maintenance budget as a first option. In fact it should be amongst the last not only because of the importance of roads to the national and local economy but it is also false economy given the number of insurance claims made against councils as a result of their failure to maintain roads adequately. The Local Government Association has calculated that councils paid out £53 million in compensation to motorists last year. Undertaking regular maintenance of roads using surface treatments is a far more sustainable and cost effective approach than structural maintenance and reconstruction. There is a wide range of surface treatments now available to ensure optimum performance of roads. They are fast to apply, generate no or minimum waste, lower the carbon foot print of roads and provide cost economies that allow local authorities to get the best value from their pressurised highways budgets.

The RSTA represents the following road surface treatments listed below;

- Surface Dressing
- Slurry-Micro Surfacing
- High Friction Surfacing
- Re-Texturing
- Infra-Red and Velocity Patching
- Pavement Preservation
- Geo-textiles
- Pavement Recycling
- Pavement Condition Monitoring
Table 1: Illustrative cost and durability comparisons for different treatments.

<table>
<thead>
<tr>
<th>Treatment Type</th>
<th>Application</th>
<th>£ / m² +/-10%</th>
<th>Expected Life years</th>
</tr>
</thead>
<tbody>
<tr>
<td>6mm Single Surface Dressing (used less now)</td>
<td>Estate roads, quiet rural areas</td>
<td>1.50</td>
<td>7 – 10</td>
</tr>
<tr>
<td>14/6mm Racked In Dressing</td>
<td>Urban roads, quiet</td>
<td>1.80</td>
<td>7 – 10</td>
</tr>
<tr>
<td>14/6mm Double Surface Dressing (relatively new)</td>
<td>Busy urban roads, higher stresses</td>
<td>2.20</td>
<td>7 – 10</td>
</tr>
<tr>
<td>Patching</td>
<td>Rural, urban roads, used pre-Surface Dressing</td>
<td>1.00 – 1.50</td>
<td>n/a</td>
</tr>
<tr>
<td>Micro-Asphalt, 14mm</td>
<td>Mainly Urban locations</td>
<td>3.00</td>
<td>7 – 12</td>
</tr>
<tr>
<td>Micro-Asphalt + regulating + ironworks raised</td>
<td>Mainly Urban locations</td>
<td>3.50 – 4.00</td>
<td>7 – 12</td>
</tr>
<tr>
<td>High Friction Surfacing</td>
<td>High stress areas</td>
<td>9 - 12</td>
<td>5 – 10</td>
</tr>
<tr>
<td>Re-texturing – bush hammer</td>
<td>Anywhere exposed aggregates</td>
<td>2 - 3</td>
<td>3 - 5</td>
</tr>
<tr>
<td>Preservation using Gilsonite based solution</td>
<td>Anywhere</td>
<td>1</td>
<td>3 - 5</td>
</tr>
<tr>
<td>Asphalt Reinforcement using geo-composites</td>
<td>Urban routes, trunk roads, heavily trafficked areas</td>
<td>5 - 8</td>
<td>Can extend asphalt life expectancy by factor of 4</td>
</tr>
</tbody>
</table>
Market Drivers for Surface Treatments

Timely intervention by selecting and applying the right surface treatment for the job will significantly extend the service life of roads, delaying the time to when structural maintenance will be required. Surface treatments should be embodied in the highway asset management planning process.

- Despite reductions in highway maintenance budgets the public will still expect roads to be maintained and not hinder their journeys.
- Because surface treatments can be applied relatively quickly they afford minimal disruption to moving traffic thereby helping to reduce traffic congestion.
- Climate change may mean more surface maintenance is required to rectify problems associated with loss of surface course texture depth due to fatting up (binder bleeding to the surface).
- Surface treatments make a considerable contribution towards government policy on sustainable travel by de-carbonising roads (reducing CO₂ emissions). Compared to using hotmix asphalt surface course materials, surface treatments have significantly less embodied CO₂. They also help local authorities to meet their carbon reduction commitments i.e. National Indicators 185 and 186.
- Protecting public safety is of paramount importance. By maintaining or improving skid resistance and by filling pot holes surface treatments make a major contribution towards achieving this aim.
- More efficient use of finite mineral reserves is another key benefit because surface treatments use far less bitumen and aggregate compared to asphalt surface course materials.

Brief Descriptions of Road Surface Treatments

Full details of each treatment can be found on the RSTA website at www.rsta-uk.org. The RSTA also run regular training courses covering all surface treatments, course details are on the RSTA website. Guidance on surface treatments is contained within the Specification for Highway Works and the Design Manual for Roads and Bridges, HD37/99 is particularly helpful. The Code of Practice for Surface Dressing can be obtained from the RSTA. There is also available a joint CSS/RSTA Code of Practice for Traffic Management on Surface Dressing Sites. Other codes of practice are currently being developed by the RSTA for Slurry-Micro Surfacing and High Friction Surfacing and these should be published in 2010.

Surface Dressing

Surface Dressing is a long established proven highway maintenance technique. In simple terms it involves the even spray application of an emulsion bituminous binder through a purpose built spray tanker onto the existing road surface followed immediately by the even application of aggregate chippings to ‘dress’ the binder.
Benefits

- Seals the road surface against ingress of water which is known to be one of the major causes of asphalt pavement deterioration.
- Arrests the deterioration of the road surface and underlying road pavement structure.
- Restores the necessary level of skid resistance to the road surface with the resultant benefits of reduction in skid related traffic accidents.
- Timely intervention will enable worn out road surfaces to last longer thereby increasing the time to when structural maintenance is required.
- Maximises the cost effectiveness of limited highway maintenance funds.
- Can be used on all classes of road from single track to motorway.
- Minimises the use of finite natural aggregate resources – most of the aggregate used is in direct contact with the vehicle tyre, not buried below the road surface.
- By careful design ‘quiet’ surface dressings can be installed to reduce road noise generated by traffic.
- Compared to re-lying hotmix asphalt, surface dressing provides a very low carbon footprint solution, typically 4 times less embodied carbon compared to asphalt.
Some Important Considerations

- Surface Dressing can be specified in accordance with the Specification for Highway Works Clauses 919 (recipe) and clause 922 (performance design).
- The dressing required must be designed for the conditions of the road surface on which it is to be laid and the traffic expected on it. The latest version of Road Note 39 gives guidance on all aspects of design.
- Emulsion binder technology has improved significantly over the last 20 years and it is important to specify the correct binder performance to minimise risk of failures.
- Good "aftercare" is essential. This, together with the correct design and binder specification, will minimise any loose chipping problems.
- The work should be carried out by an experienced contractor who can demonstrate that he has a record of quality work. All RSTA surface dressing member companies are accredited to ISO 9001 Quality Standard and most have achieved accreditation to National Highway Sector Scheme No 13a - Surface Dressing. Clients are urged to specify such quality accreditation requirements in their contract documents.
- The Code of Practice on Surface Dressing, available from RSTA, covers every aspect of the process and should be regarded as representing best practice.
- There is also a joint CSS/RSTA Code of Practice on Traffic Management and Signage relating to Surface Dressing works.
High Friction Surfacing

High Friction Surfacing has a long history of proven use in saving lives by imparting the highest level of skid resistance onto a road surface. High Friction Surfacing is available as hot or cold applied systems. The cold applied technique involves the even application of a tough polymeric liquid binder onto the road surface followed by the application of calcined bauxite aggregate. The hot applied systems involve the application of a hot pre-mixed material consisting of binder and calcined bauxite.

The concept was first investigated in the USA during the 1950’s using epoxy resin binders and was first known as “Anti-skid Surfacing”. In the UK, the first evaluation trials were conducted in 1967 for the Greater London Council. The study over a period of 12 months demonstrated a 50% reduction in accidents and casualties on roads treated with High Friction Surfacing.

The use of High Friction Surfacing was fairly limited in the 1970’s due to its relative high cost and limited highway budgets. Applications grew steadily in the 1980’s when Highway Engineers could balance the cost of High Friction Surfacing against a broader savings strategy. Effectively, budgets were allocated for accident investigation and prevention, demonstrating returns on the investment in High Friction Surfacing at accident black Spots compared with the savings in casualty reduction.

The growth of High Friction Surfacing accelerated in the late 1980’s and early 1990’s, largely in parallel with the Traffic Calming Act and the development of alternative resin processes to the original epoxy resin systems.
Benefits and Features

- Designed to enhance the skid resistance of trafficked surfaces.
- A high strength veneer surfacing, typically 3-5mm thick.
- Durable able to withstand high braking and shearing forces.
- Should only be applied onto sound substrates that have been well prepared and are in fair to good condition.
- Accredited for substrates with a texture depth up to 2mm.
- Regulated by the British Board of Agrément (BBA) HAPAS certification scheme covering products and approved installers.
- BBA "Type 1" High Friction Surfacing is the highest classification, "Type 3" lowest classification.

Some Important Considerations

- The Design Manual for Roads and Bridges deals with the design standards for Highways. The relevant standards for High Friction Surfacing in these documents are: HD37/99 and HD28/04.
- Designed for use on sites where there is high risk of accidents resulting from collisions between vehicles or between vehicles and pedestrians e.g. on approaches to pelican crossings, roundabouts, junctions and crossings.
- Financially, there are major cost consequences for emergency services, local and national governments. It is estimated that one fatality on a non-motorway road costs £1.4M and on a motorway £1.7M.
- All classes of road, from single track, unclassified roads to high speed urban routes, trunk roads and motorways can and have been successfully treated.

Slurry-Micro Surfacing

These materials are cold-applied, thin bituminous surface courses incorporating bitumen emulsion and fine graded aggregate with fillers and cement. They can be used to restore the surface condition on roads, footways, cycle ways, car parks, playgrounds, central reservations, traffic islands and amenity areas. Slurry Surfacing is normally a single coat application laid mechanically or manually up to a dried film thickness of 6mm. Micro-surfacing incorporates a polymer modified bitumen emulsion and is often a two-coat application and can be laid mechanically or manually to a maximum dried film thickness of 15mm. These materials are usually referred to as Micro-Asphalts.
Micro-Surfacing

Benefits

- Rapid curing characteristics – able to receive traffic within twenty minutes.
- High daily output means less traffic disruption.
- Restores surface texture and improves skid resistance.
- Impervious membrane prevents ingress of water into the pavement structure.
- Seals and preserves existing surfaces.
- Suitable for overlay on wide range of existing surfaces.
- Micro-surfacing has the ability to reshape and re-profile existing surfaces.
- Able to provide smooth or textured finish.
- Pigmented materials are available to give an aesthetically pleasing finish.

Some Important Considerations

- Apply before the footway or carriageway surface deteriorates to the stage at which expensive major patching and/or reconstruction is required.
- Use before surface skidding levels fall below the nationally accepted intervention level for the class of road in question or when the road surface profile needs minor restoration.
- Slurry surfacing is ideal for any type of surfacing receiving mainly pedestrian traffic e.g. footways and cycleways.
- Micro-Asphalts are ideal for use on urban roads and roads carrying up to 250 commercial vehicles per lane per day.
• Slurry-Micro Surfacing can be specified in accordance with the Specification for Highway Works Clause 918.
• EN 12273:2008 comes into effect in UK in January 2011 and UK specification guidance on Surface Treatments is available in PD 6689:2009.
• The Slurry-Micro surfacing must be designed by the contractor to meet the requirements of the road surface on which it is to be laid.
• The work should be carried out by a fully experienced contractor who can demonstrate that he has a record of quality work.
• All Slurry-Micro contractors who are members of RSTA have achieved accreditation to the National Highway Sector Scheme No 13b – Slurry-Micro Surfacing. Clients are urged to specify such quality accreditation requirements in their contract documents.
• Good "aftercare" is essential. This, together with the correct material design will minimise the risk of early life failure.

Re-Texturing
Re-texturing is described in the Design Manual for Roads and Bridges (DMRB) as the mechanical reworking of an existing surface to improve its frictional characteristics and hence its skid resistance.
Apart from improving road safety and addressing the issues that the government’s casualty reduction targets introduce, the re-use of existing road surfacing materials will considerably reduce the attendant energy consumption in quarrying, processing, laying new road surfacing materials and waste removal. By extending the life of existing surfaces and by making best use of what you’ve got, the conservation of substantial quantities of irreplaceable high quality aggregate is ensured. Re-texturing also results in a significant reduction in carbon emissions. Even several repeat treatments would not generate the same carbon footprint as one layer of hot mix asphalt.
Benefits

- Non-trafficked areas and surface markings are avoided, further minimising works costs.
- Restores the necessary level of skid resistance to the road surface with the resultant benefits of reduction in skid related traffic accidents.
- Roads can be treated even in wet conditions.
- Timely intervention will enable road surfaces to last longer thereby increasing the time to when structural maintenance is required.
- Rapid treatment thereby minimising disruption to the road user, local businesses and emergency services.
- Uses no additional materials – no aggregates or binders are used.
- Compared to re-laying hotmix asphalt, retexturing provides a very low carbon footprint solution.
- Generates minimal if any waste.

Some Important Considerations

- Use before surface skidding levels fall below the nationally accepted intervention level for the class of road in question.
- Can be used on all classes of road.
- Guidance is available in DMRB, Vol.7 Pavement Design & Maintenance, Section 5, Surfacing & Surfacing Materials;
  - Part 2: HD 37/99, Chapter 11, Re-texturing (Bituminous).
  - Part 3: HD 38/97, Chapter 4, Re-texturing (Concrete).

- The work should be carried out by an experienced contractor who can demonstrate that he has a record of completing quality work.
- There are various different types of retexturing processes so it is important the client appreciates what each process offers and to select the correct technique for the job in hand.
- The suitability and effectiveness of a particular retexturing process depends largely on the type and condition of the existing road surface.
- The durability of the treatment is also a function of aggregate quality and again the condition of the existing surface.

Asphalt Reinforcement

A range of geo-synthetics, geo-textiles and special proprietary glass-polymer bound reinforcing systems are increasingly being used as a means of extending the life of existing or old road surfaces across Europe by strengthening the pavement structure, absorbing traffic related stresses and restricting the development of reflective cracking. They can be used in conjunction with a surface dressing technique for short to medium term benefits, in the reconstruction of existing roads following the milling/planning process to remove the top surface or in new construction where the benefits can be designed into the project.
An example of a Geo-Synthetic

Benefits

- Reduction in reflective cracking and aids stress relief in the surface course.
- Effective seal to prevent the penetration of water and oxygen to the lower levels of the construction.
- Strengthens the road and enhances resistance to rutting.
- Extends the life cycle of the road surface and reduces maintenance costs.
- Improves the bond between adjacent layers or between old and new surfaces.
- Life cycle costing indicates the life of road surfaces can be extended by a factor of four.

Some Important Considerations

- Can be employed at the initial design stage of a road leading to improved life cycle costing and extended design life for the construction.
- Can be applied as a maintenance or repair method in conjunction with surface dressing or after planning has taken place to remove the surface course.
- Installation must be carried out by an experienced contractor whose methods are approved by the manufacturer of the geo-composite being proposed.
- All operatives should be well trained and competent in the laying of the product and possess a minimum of an NVQ Level 2 Certificate.
- Planing/milling must be carried out to the required standard before the approved installer can proceed.
- Surface preparation is critical.
- Any cracks exceeding 4mm wide or pot holes should be filled with a suitable asphalt or bituminous material.
- A regulating course may be required if the surface is of poor quality.
- Bond coats are applied by specialist contractors.
Velocity Patching

A rapid patching technique suitable for use on rural and urban roads using cold emulsion asphalt which is placed into the void depression in the road surface under high pressure. The void is first blasted with compressed air to clean the surface and remove any debris, then the surface of the void is sprayed and coated with bitumen emulsion. Finally the asphalt is blasted into the void, self compacting from the bottom up so requiring no additional compaction.

Velocity Patching

Benefits

- Low carbon footprint compared to using hotmix asphalt.
- No waste generated.
- No excavation so no damage caused to the lower layers.
- Fast installation so minimal disruption to road users – reduced traffic management costs.
- Can receive traffic immediately.
- Can save up to 80% cost compared to conventional repairs.
- Higher daily outputs compared to conventional asphalts.
- No noise, no dust, no hand arm vibration issues.
Some Important Considerations

- Good bond achieved with existing substrate.
- Mobile equipment mounted on motorised vehicle.
- Efficient 2 man operation.
- The process is suitable for repairing the following:
  - Potholes – preventative, programmed and emergency.
  - Pre-surface dressing patching.
  - Edge deterioration, haunching.
  - Sealing and extending the life of worn conventional repairs.
  - Depressions, cracking and crazing.

Patching Using Infra-Red Heating

The principal of this technique is to re-heat the damaged area on the surface course using targeted infra-red then re-work the warm mobile asphalt material with a small addition of emulsion binder and aggregate as necessary, followed by compaction to make good the patch.

Benefits

- Reduces the carbon footprint compared to traditional asphalt patching by about 85%.
- Recycles existing asphalt surface course.
- No waste to landfill.
- Minimal additional aggregate and binder needed to complete the patch repair.
- No saw cutting/ jack hammering – no dust, no noise and no hand arm vibration issues.
- An emulsion binder is used which is environmentally friendly.
- Timely intervention will enable repaired road surfaces to last longer thereby increasing the time to when structural maintenance is required.
- Maximises the cost effectiveness of limited highway maintenance funds.
Some considerations

- Infra-Red patching can be specified in accordance with Clause 946 in the Specification for Highway Works but the contractor will require a BBA HAPAS certificate for the proposed system.
- The work should be carried out by a fully experienced contractor who can demonstrate that he has a record of quality work.

Pavement Preservation

Preservatives work by applying a mineral based solution (e.g. Gilsonite) onto the existing surface course. This penetrates below the surface to a depth of a few millimetres dependent on the type of asphalt surfacing creating a Gilsonite rich membrane which binds together aggregate and surface fines. This membrane seals the pavement against water and salt ingress and seals in essential oils and resins.

Benefits

- Arrests the deterioration of the road surface and underlying road pavement structure.
- Extends the life of the surface course for 3-5 years depending on the pavement condition at the time of treatment.
- Rapid application, so minimal disruption to road users.
- Can be re-treated every 5 years.
- Requires no additional aggregates.
- Maximises the cost effectiveness of limited highway maintenance funds.
- Generates no waste.
- Typically 94% saving in CO₂ emissions when compared to hot mix asphalt.
- Helps to prevent water ingress into the pavement structure.
Some Important Considerations

- The work should be carried out by a fully experienced contractor who can demonstrate that he has a record of quality work.
- Should only be applied onto surface courses that are sound and in reasonable condition to obtain maximum value.
- Can be used on all classes of road.
- The appearance of a treated road surface remains unchanged after treatment.

Road Recycling and Stabilisation

The principal of road recycling is to use the existing road effectively as a linear quarry by recycling the existing worn out road back into a structurally sound pavement structure. Unlike the other surface treatments this technique involves deep layer recycling so in effect the full road depth can be treated and recycled. Or alternatively the process can be used to stabilise a foundation layer (soil stabilisation) as part of new works prior to overlaying with sub-base and bound layers.

Road Recycling

Benefits

- Cost savings of up to 30% compared with conventional treatments.
- Effective solutions within restricted budgets.
- Less expenditure on imported materials e.g. aggregates and binders.
- Faster contract completion – c. 60% faster than other repair methods.
- High daily productivity - up to 1,500m² treated in a single day.
- Recycled road foundation can accept surfacing and traffic quickly.
- Less traffic congestion and need for long term diversion schemes.
- Recycling in-situ material conserves natural resources.
- Fewer lorry movements, saving energy and reducing impact on local community.
- Fewer disposals to scarce landfill sites.
- Reduces CO₂ emissions.
Some Important Considerations

- Various recycling processes are available using different binders including lime, pfa, foamed bitumen depending on the requirements of the job.
- Both in-situ and ex-situ process are available.
- Suitable for recycling virtually any class of road.
- Should form part of asset management planning to recycle the road at the end of its service life.

Road Surface Condition Monitoring

The RSTA also represents member companies who provide innovative testing services to measure the skidding resistance of road surfaces. Highway authorities have a responsibility to the public to ensure that appropriate skid resistance is provided across the whole network, both for safety reasons in respect of skidding and to provide a defence in case of litigation (Code of Practice for Maintenance Management, published by The Institution of Highways and Transportation).

Local authorities should have an effective monitoring process in place across their road network in order to meet their obligations. The Grip Tester is a cost effective, reliable and deployable skid resistance tester as proven by trials undertaken by the Transport Research Laboratory.

Grip Tester MK2 for measuring skidding resistance

Acknowledgments

The author would like to thank the RSTA members for assisting with providing background information for this paper.