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The Road Surface Treatments Handbook

For as long as anyone can remember road surface treatments have played an important role in helping highway authorities to maintain the UK road network. This is particularly so during periods when authorities for one reason or another have less money to spend on highway maintenance. In this context authorities will tend to look more towards preventative maintenance to make their road assets last longer thereby delaying the time to when major investment becomes necessary.

The earliest and still the most widely used treatment is surface dressing which is a very familiar technique to highway authorities with a long and proud history of successful use. Over recent years however the industry has witnessed the introduction and growth of a wider range of specialist techniques to enrich the engineer’s toolbox enabling alternative maintenance strategies to be adopted in the search for best value.

The main purpose of this handbook is to provide a quick and easy reference guide to help anyone involved in highway maintenance and asset management to more fully appreciate the range of techniques now available, where they can be used and what they have to offer.

The narrative of this handbook is fundamentally based on a series of Codes of Practice written by industry practitioners, peer reviewed by ADEPT and published by the RSTA. Thanks must go to everyone who invested their precious time and who contributed an enormous amount of knowledge and experience in writing these industry guidance documents. Without their efforts this handbook would not have been possible.

Dr Howard Robinson
Chief Executive
RSTA
Advanced and effective solutions to improve and renew the surfaces of roads, footways, car parks and airfields nationally

- Surface Dressing
- Viasealer
- Micro Surfacing
- Gripfibre®
- Gripseal®
- High Friction Surfacing
- Decorative Surfacing
- Flexiplast
- Footway Surfacing
Why the right road treatments matter

Howard Robinson from the Road Surface Treatments Association (RSTA) describes best practice in the area of surface dressing

Over recent years it has been well reported in the media that crumbling roads are costing the national economy around £20 billion every year and councils an annual £53 million in compensation claims, according to the Local Government Association.

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 this 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 backlog of repairs is some £12 billion.

Despite the fact roads represent the biggest asset under the control of local authorities this neglect is likely to continue for the foreseeable future as councils need to make budgetary savings across the board.

However many councils are aware that surface dressing is the most economic maintenance option for sealing the road surface whilst restoring skid resistance and helping to prevent pothole formation. Yet despite the economic downturn we haven’t yet seen a major increase in the use of surface dressing across the UK since the market fell by around 40% in the early to mid 1990s coinciding with the introduction of asphalt thin surfacings. As the asphalt market has declined over the past decade surface dressing could have been expected to make a major comeback but this hasn’t yet materialised which is somewhat surprising.

Regular maintenance

Undertaking regular and timely maintenance of roads using surface treatments such as surface dressing in the current economic climate is a far more sustainable and cost effective approach than allowing roads to deteriorate to a poor condition requiring more costly intervention. There are a wide range of surface treatments now available to ensure optimum performance of roads that are fast to apply, generate no or minimum waste, lower the carbon footprint of roads and provide cost economies that allow local authorities to get the best value from their pressurised highways budgets.

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 the cut backs in expenditure the public will still expect roads to

Road workers carrying out resurfacing
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. In future 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 decarbonising roads (reducing CO₂ emissions). More efficient use of finite mineral reserves is another key benefit because surface treatments use the minimum amount of bitumen and aggregate to restore the surface condition.

Background to surface dressing
Surface dressing is a long established proven highway maintenance technique with its introduction pre-dating World War Two. Indeed the Road Surface Dressing Association (now part of RSTA) was formed in 1942 to help maintain Britain’s roads during an earlier period of austerity. 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.

To the highway engineer, surface dressing offers a quick, efficient and cost-effective way of maintaining skid-resistance and waterproofing road surfaces. To obtain the best results it is necessary to give careful consideration to a wide range of detail and to plan and design the work carefully. The speed of the surface dressing operation and the short duration of time during which motorists are inconvenienced is also an important issue.

The importance of surface texture as provided by surface dressing has been highlighted by TRL report LR 286, which stresses that texture depth is important under both wet and dry conditions. Up to date guidance is available in the Design Manual for Roads and Bridges (DMRB): Volume 7 HD 28. The DMRB is available online at www.dft.gov.uk/ha/standards/dmrb/.

A useful way of comparing the effectiveness of a dressing, or other maintenance work, is to express it in terms of a ‘cost life index’. This is the cost per square metre of the work divided by the service life in years. It provides a measure of the “value for money” which the highway authority is achieving. A low ‘cost life index’ and “high value for money” is the result of high-quality work.

The Code of Practice for Surface Dressing published by RSTA (Road Surface Treatments Association) and endorsed by ADEPT (Association of Directors Environment, Economy, Planning, Transportation) aims to identify the important aspects of the process, and to refer to other documents relating to good surface dressing practice and so give practical guidance on achieving high quality.

Surface dressing offers many advantages:
- Seals the road surface against ingress of water which is known to be one of the major causes of asphalt pavement deterioration and pothole formation
- Arrests the deterioration of the road surface and underlying road pavement structure by helping to keep water out of the 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 budgets.

When to surface dress
- Before the road surface deteriorates to the stage at which expensive major patching and/or resurfacing is required
- Before surface skidding levels fall below the nationally accepted intervention level for the class of road in question.

Cost effectiveness
- Low initial cost - in the region of £1.20 per m² for routine single dressings to £2.50 per m² for specialist multi-layer dressings for higher speed roads
- Low cost/life index. When done properly, at the right time, surface dressing is a cost effective treatment costing around £0.2 per m² per annum (assuming a 10 year service life)
- Surface dressing can be likened to painting one’s house. It needs doing before serious deterioration occurs and means that expensive preparation or replacement costs can be delayed for years.

Which roads can be surface dressed?
- All classes of road, from single track, unclassified roads and footpaths to principal routes and even motorways have been successfully treated.

Important technical considerations
- Surface dressing can be specified in accordance with the specification for highway works clauses 919 (recipe) and 922 (performance design)
- Surface dressing, when designed and installed by the contractor, is regarded as a ‘product’ regulated by the new construction products regulations (CPR) that came into force on 1 July 2013. This means that these surface dressing ‘products’ must be CE marked and have a declaration of performance stating the products characteristics in accordance with BSEN12271. National guidance document PD6689 provides guidance on the level of performance required for the UK market.
The selection of the right type of dressing, size of chippings and rate of spread of binder is as important as the design of other engineering works. Each site must be considered in the light of its unique characteristics, including the nature of surface, geography, volume and speed of commercial and other traffic using the section of road. Advice on the design of surface dressing is contained in the sixth edition of Road Note 39 ‘Design Guide for Road Surface Dressing’ (2008) published by TRL Limited, Crowthorne House, Nine Mile Ride, Wokingham, Berkshire, RG40 3GA. http://www.trl.co.uk/default.htm

The surface dressing installation should be carried out by experienced and competent contractors with a fully trained and qualified workforce. The RSTA run regular training courses on surface dressing for operatives and technicians providing tuition on every aspect of the process from site selection, surface preparation, choosing the right types of dressing, standards and specifications through to design – see www.rsta-uk.org/calendar for all training course dates.

All RSTA surface dressing member organisations (including a number of DLOs) are accredited to ISO 9001 Quality Standard and are registered to National Sector Scheme 13 for the supply and application of surface treatments to road surfaces.

Surface dressing binder technology has developed enormously over the last 20 years or so. It is important to specify the binder quality required to give the optimum end product. Failures will be minimised by the correct binder selection. The use of polymer modified binders has grown significantly over the past 20 years and they now dominate the market.

Proper aftercare is essential. This, together with the correct design and binder specification, will minimise any loose chipping problem.

The code of practice on surface dressing available from RSTA and endorsed by ADEPT 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 also available at www.rsta-uk.org/publications.htm.

Clients are urged to specify this list of criteria in their contract documents to minimise risk, enhance product durability and get best value for money.

Considering the environment

Surface dressing minimises the use of scarce high PSV chippings resources - most of the aggregate used is in direct contact with the vehicle tyre, not buried below the road surface.

Accident levels will be reduced by restoring adequate skid resistance.

By careful design ‘quiet’ surface dressings can be installed to reduce road noise generated by traffic.

The rapid speed of the process means that disruption to road users, local businesses and emergency services is minimised.

Surface dressing provides a low carbon footprint solution as measured using the RSTA carbon calculator suite known as Protect (Pavement Road Treatment Embodied Carbon Tool). For information on measuring the carbon footprint of surface dressing and other surface treatments contact enquiries@rsta-uk.org.

Life expectancy

Proper attention to design and execution has provided surface dressing lifetimes well in excess of 10-15 years, even on very heavily trafficked sites. In 2011, RSTA and ADEPT jointly published the Service Life of Surface Treatments document to advise asset managers how long surface treatments on average can be expected to last. This document is available from the RSTA and ADEPT’s website.

Summary

Surface dressing is an established, proven process. It is an extremely cost-effective preventative maintenance treatment when properly designed, specified and executed. Developments in surface dressing materials, techniques and equipment and improved operator training mean the risk of failure has been significantly reduced.

For further detailed information on surface dressing download the code of practice from the RSTA website www.rsta-uk.org/publications.htm.
High friction surfacing (HFS) has a long history of proven use in saving lives by imparting the highest level of skid resistance onto a road surface and is available as hot applied or cold applied systems. Cold applied HFS systems are similar to surface dressing in that they involve the even application of a tough polymeric liquid binder onto the prepared 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 1950s 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 skid related accidents and casualties on roads treated with high friction surfacing.

The use of high friction surfacing was fairly limited in the 1970s due to its relative high cost and limited highway budgets. Applications grew steadily in the 1980s 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 1980s and early 1990s, largely in parallel with the traffic calming act and the development of alternative resin processes to the original epoxy resin systems. The current UK market is around two million square metres per annum.

How does HFS work?
The high level of skid resistance is imparted by the calcined bauxite aggregate used in HFS systems. Calcined bauxite is a manufactured aggregate with exceptional resistance to abrasion caused by vehicle tyres combined with a very high resistance to polishing - polished stone value (PSV) of 70+. Calcined bauxite micro-texture results in reduced contact points with vehicle tyres creating high contact pressure points and improved hydraulic conductivity which are critical for high skid resistance (Parry,TRL,1996).

When to use high friction surfacing
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, junctions and crossings).

Cost effectiveness
Tragic loss of life or serious injury has an immeasurable cost to the accident victims, their families and friends

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.

The table (right) is courtesy of RoSPA (Royal Society for the Prevention of Accidents) and shows how HFS reduced accidents by 57% measured on 34 schemes and delivered a first year rate of return of 352%.

Which roads can be treated with high friction surfacing?
All classes of road, from single track, unclassified roads to high speed urban routes, trunk roads and motorways can and have been successfully treated

High friction surfacings can be specified in accordance with The Specification for Highway Works Clause 924.

RSTA ADEPT code of practice for high friction surfacing
Published in 2011 and peer reviewed and endorsed by the Association of Directors for Environment Economy Planning and Transportation (ADEPT).
Analysis of schemes (<£100,000) by category
Key: FYRR = First Year Rate of Return (100% = 1 year)

<table>
<thead>
<tr>
<th>Category</th>
<th>No. of schemes</th>
<th>Av. Cost £</th>
<th>Reduction in Accidents %</th>
<th>FYRR %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anti-skit</td>
<td>34</td>
<td>8,620</td>
<td>57</td>
<td>352</td>
</tr>
<tr>
<td>Area Traffic Calming</td>
<td>14</td>
<td>46,093</td>
<td>57</td>
<td>216</td>
</tr>
<tr>
<td>Controlled Crossing</td>
<td>73</td>
<td>15,916</td>
<td>31</td>
<td>89</td>
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<tr>
<td>Markings</td>
<td>43</td>
<td>2,020</td>
<td>34</td>
<td>957</td>
</tr>
<tr>
<td>Markings &amp; Signs</td>
<td>63</td>
<td>2,537</td>
<td>41</td>
<td>820</td>
</tr>
<tr>
<td>Refuges</td>
<td>65</td>
<td>10,387</td>
<td>37</td>
<td>259</td>
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<tr>
<td>Package Schemes</td>
<td>97</td>
<td>22,099</td>
<td>42</td>
<td>171</td>
</tr>
<tr>
<td>Signal Improvements</td>
<td>16</td>
<td>17,095</td>
<td>22</td>
<td>155</td>
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<tr>
<td>Speed Limits</td>
<td>6</td>
<td>1,117</td>
<td>33</td>
<td>1,035</td>
</tr>
<tr>
<td>Traffic Calming Horizontal</td>
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<td>46</td>
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<td>Traffic Calming Vertical</td>
<td>58</td>
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<td>Warning Signs</td>
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<td>Junction Improvements</td>
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<td>18,513</td>
<td>44</td>
<td>168</td>
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<td>New Traffic Signals</td>
<td>15</td>
<td>40,717</td>
<td>67</td>
<td>133</td>
</tr>
<tr>
<td>Mini Roundabout</td>
<td>18</td>
<td>14,769</td>
<td>49</td>
<td>134</td>
</tr>
<tr>
<td>Yellow bar markings to slip roads</td>
<td>1,000</td>
<td>25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yellow bar markings to roundabouts</td>
<td>1,000</td>
<td>50</td>
<td></td>
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</tr>
</tbody>
</table>

The document is reviewed annually by the RSTA/ADEPT working party to ensure it remains rigorous, accurate and up to date to serve the needs of local authorities. It is freely available on the RSTA website www.rsta-uk.org/publications.htm

This code of practice has been written by the Road Surface Treatments Association and ADEPT to assist procurers and installers to obtain a high quality durable surface treatment. It represents best practice for the selection and application of high friction surfacing systems to maximise their performance and durability

To obtain the best results it is necessary to give careful consideration to a wide range of details and to plan and design the work carefully and to use only HAPAS approved installers. HAPAS categorises systems as type 1, 2 and 3, where type-1 has attained the highest performance level. All comply with Clause 924 of the Specification for Highways Works, part of the manual of contract documents for highway works.

The type of application in which the materials are applied and the prevailing ambient conditions at the time of installation are also important to ensure long term durability of the product.

The purpose of this code is to identify the important aspects of the process, and to refer to other documents relating to good applications of high friction surfacing and so give practical guidance on achieving high quality.

The code discusses how to determine suitable sites for treatment and considers the different types of HFS systems in terms of composition, manufacture and installation. Specification issues are covered in some detail and it highlights the clients responsibilities towards achieving a successful outcome. It goes into some detail regarding planning and coordination, health and safety aspects, planning the execution of the works, traffic management and good surface preparation which is regarded as being a key factor affecting durability.

The document contains a new specification for calcined bauxite aggregates and provides a framework for the contactor to offer a five year guarantee providing the code of practice is followed to the letter. Guidance is also provided on how soon freshly laid asphalt surfacings can be treated depending on the choice of HFS system.

Training the workforce is also a major topic covered in the document. It is imperative that local authorities ensure their contractors have properly trained and qualified operatives with an NVQ level 2 in HFS and an appropriate CSCS card to ensure good workmanship which has a major impact on durability. There is also a checklist for contractors before, during and after the works and a glossary of terms.

Some important benefits and features

- Designed to enhance the skid resistance of trafficked surfaces
- A high strength veneer surfacing, typically 3-5mm thick
- HFS systems properly specified and installed on a well prepared substrate have been shown to provide the highest level of skid resistance over a 10 year service life
- Should only be applied onto sound substrates that have been well prepared and are in fair to good condition

Environmental considerations

- Accident levels will be reduced by importing the highest attainable skid resistance
- The rapid speed of the process means that disruption to road users, local businesses and emergency services is minimised.

Life expectancy

- Careful attention to material selection and installation has provided service lifetimes of typically five to 10 years
- Cold applied HFS systems have an average service life of eight years and hot applied four years (Ref: RSTA/ADEPT code of practice for high friction surfacings)
- Calcined bauxite has proven to be extremely durable and able to withstand high braking and shearing forces over many years.

Summary

- High friction surfacing is an established, proven process for saving lives by imparting the highest level of skid resistance onto any road surface
- It is an extremely cost effective solution when compared to the value prevention by avoiding collision related fatalities
- Installed by specialist companies and organisations
- Requires well trained operatives and specialist plant
- Suitable for all vehicular traffic
- Adaptable to cycleways or pedestrian surfaces
- Commonly referred to as anti-skid surfacing.
Through thick or thin

The two categories of slurry surfacing discussed

Slurry surfacing incorporating micro-surfacings are cold-applied, thin bituminous surface courses using bitumen emulsion binders and fine graded aggregates with fillers and other additives. There are two broad categories; thin slurry surfacings used for treating footways and thicker polymer modified surfacings called micro-surfacing or micro-asphalt for carriageways.

Where can they be used?
These materials can be used to restore the surface condition on roads, footways, cycleways, car parks, playgrounds, central reservations, traffic islands and amenity areas.

Slurry surfacing is ideal for any type of surfacing receiving mainly pedestrian traffic e.g. footways and cycleways.

Micro surfacing is ideal for use on urban roads and roads carrying up to 250 commercial vehicles per lane per day. Some products have a HAPAS certificate which enables them to be used on more heavily trafficked roads.

What is the difference between slurry and micro surfacing?
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 laid mechanically or manually to a maximum dried film thickness of typically 15mm.

These materials are usually referred to as micro-asphalts.

What are the benefits?
- These treatments are very cost effective compared to conventional resurfacing
- Restores surface texture and improves skid resistance
- Rapid curing characteristics – some micro-surfacings can receive traffic about 20 minutes after installation
- High daily outputs mean minimal traffic disruption and congestion
- They seal the surface preventing ingress of water into the pavement structure thereby helping to minimise pothole formation
- Suitable for overlay on a wide range of existing surfaces
- Micro-surfacing has the ability to reshape and re-profile existing surfaces by filling shallow defects such as potholes, cracks and ruts
- Able to provide a smooth or textured finish
- Available in a range of colours providing an aesthetically pleasing finish.

When to use slurry and micro-surfaces
- Before the footway or carriageway surface deteriorates to the stage where expensive major patching and/or reconstruction is required
- Before surface skidding levels fall below the investigatory level for the class of road in question
- When the road surface profile needs minor restoration.

Cost effectiveness
- Slurry surfacing costs in the region of £2.50/m² and micro-surfacing costs £3 to £4/m², towards the higher end if the process involves surface regulating and ironworks
- They also provide good value offering an average service life in excess of 10 years or a cost life index of less than £0.40 per year.

Some important considerations
- Slurry surfaces and micro-surfaces can be specified in accordance with the specification for highway works clause 918
- These materials are recognised as products regulated by the Construction Products Regulations (CPR) and European Standard BSEN 12273. Contractors must now provide a CE mark and a declaration of performance for each type of slurry surfacing and micro-surfacing product placed on the market
- Further guidance is available within the Design Manual for Roads and Bridges (DMRB) HD37
- These products are designed by the contractor to meet the requirements of the road surface on which they are laid
- The work should be carried out by an experienced contractor who can demonstrate a good track record of high quality work
- All contractors who are members of the RSTA have achieved accreditation to the national highway sector scheme 13 for the supply and application of surface treatments to road surfaces.
Sector schemes are competency schemes aimed at ensuring the workforce have been properly trained and qualified.

Good “aftercare” is essential. This, together with the correct material design will minimise the risk of early life failure.

Environmental considerations

These products have a relatively low carbon footprint. RSTA in association with the University of Nottingham have published a suite of carbon calculators for measuring the carbon footprint on schemes using surface treatments including slurry surfacing and micro-surfacing.

These new carbon tools are called PROTECT (Pavement Road Treatment Embodied Carbon Tool) and have been endorsed by ADEPT.

The rapid speed of the process means that disruption to road uses, local businesses and emergency services is minimised.

They are applied cold at ambient temperature so they have zero emissions and zero risk of fume installation and burns to operatives during installation.

Life expectancy

Careful attention to material design and execution has provided in service performance of typically eight to 12 years (average 10 years life) on trafficked sites.

Further information on service life is available in the RSTA ADEPT service life of surface treatments document published in 2011 available at www.rsta-uk.org/publications.htm.

RSTA/ADEPT code of practice

Originally published in 2011 and peer reviewed and endorsed by the Association of Directors for Environment Economy Planning and Transportation (ADEPT).

The document is reviewed annually by the RSTA-ADEPT working party to ensure it remains rigorous, accurate and up to date to serve the needs of local authorities.

It is freely available on the RSTA website www.rsta-uk.org/publications.htm.

This code of practice has been written by the Road Surface Treatments Association and ADEPT to assist procurers and installers to obtain a high quality durable surface treatment. It represents best practice for the selection and application of slurry and micro surfaces to maximise their performance and durability.

To obtain the best results it is necessary to give careful consideration to a wide range of details and to plan and design the work carefully and to use experienced contractors with a good track record. All of these products comply with clause 918 of the specification for highways works, part of the manual of contract documents for highway works.

The type of application in which the products are applied and the prevailing ambient conditions at the time of installation are also important to ensure long-term durability of the product.

The purpose of this code is to identify the important aspects of the process and to cross reference other documents relating to good applications of slurry and micro surfacing and so give practical guidance on achieving high quality.

The code discusses how to determine suitable sites for treatment.

Specification issues are covered in some detail and it highlights the clients’ responsibilities towards achieving a successful outcome. It goes into some detail regarding planning and coordination, health and safety aspects, planning the execution of the works, surface preparation, controlling material installation, and traffic management. It also covers aggregates and binders used in these products, rollers, sweeping, method of working and aftercare. There is also a section on hand applied footway slurry surfacing.

Training the workforce is also a major topic covered in the document. It is imperative that local authorities ensure their contractors have properly trained and qualified operatives with an NVQ level 2 in slurry surfacing and an appropriate CSCS card to ensure good workmanship which has a major impact on durability. There is also a checklist for contractors before during and after the works and a glossary of terms.

Summary

Slurry surfacing incorporating micro-surfacing is an established, proven process with a long history of successful use.

It is an extremely cost-effective surface maintenance treatment when carefully designed, specified and executed.

Developments in materials, techniques and equipment and improved operator training mean there is a very low risk of early life failure.
The best kept secret on the road

RSTA chief executive Howard Robinson talks about a well-kept secret in the industry and how its use can lead to longer lasting roads

Grouted macadams are products evolved from a simple idea: to alter the physical characteristics of a new running surface to meet a specific need and to make the surfacing super strong and tough with high durability. The two variants are cementitious and asphaltic grouted. Cementitious grouted macadams originated in France in the early 1950s. Since then the use of these materials has spread to other countries, entering the UK market in the mid 1960s. The asphaltic grouted macadam was developed in the UK in 1993 for the national road network to provide increased flexibility and performance.

Grouted macadams offer an innovative solution to problems which conventional asphalts struggle to cope with. Yet despite having BBA certification and latterly HAPAS certification these products have remained a well kept secret for many years and rarely make the headlines. For example 120,000m² was laid on the new London Gateway Container Terminal in 2013.

In total, more than six million square metres of asphaltic grouted macadam has been laid on most local authority roads across the UK.
and likewise millions of square metres of cementitious grouted macadam.

**How is it installed?**
The process involves laying an open graded asphalt surface course typically 30 to 50mm thick with controlled air voids, then applying a liquid grout to fill the voids in the asphalt. The surface course is vibrated to ensure the grout penetrates to the required depth and the surface is normally brushed to expose the coarse aggregate, ensuring adequate texture depth and skid resistance. The grout can either be a liquid asphalt or liquid cementitious.

**Where can it be used?**
Asphaltic grouted macadam obtained HAPAS certification in 2006 and can be used on most residential and rural roads. It has a large loyal following for the resurfacing of concrete carriageways as it offers a fully impervious flexible covering, ensuring protection of the underlying structure and comes with a joint treatment package.

Cementitious grouted macadams have been BBA certificated since 1986 and HAPAS certificated since 2006. They are laid where traffic loading is extremely heavy and concentrated or where there is spillage of fuel or industrial chemicals. Instances where they would be laid within the public road network would include bus infrastructure works, roundabouts, junctions and amenity waste sites.

Many local authorities are now adopting both variants on their highways networks in combination, as they can offer long-term solutions to the multitude of stresses that might affect any single carriageway. Their uses in these combined situations can either be made visible to the public or to merge with each other by the subtle use of pigmentation. The ease by which colour can be added to a grouted macadam, mainly black, red, green or buff provides another strong argument for their use by engineers and traffic managers.

**What are the benefits?**
These materials provide a reinforced impervious surface with major advantages over conventional bituminous materials. These advantages include:

- **Fuel/oil and chemical resistance**
- **High abrasion resistance**
- **High compressive strength**
- **Reduced permeability**
- **Improved durability**
- **They provide a high strength but flexible heavy duty surface course ideally suited to areas of high loading and turning stresses. Grouted macadams do not rut under channelised traffic.**
- **Although some products on the market have HAPAS certification, some do not so the client needs to determine to what extent third party certification is required**
- **To obtain the best results it is necessary to give careful consideration to a wide range of details and to plan and design the work carefully and to use experienced contractors with a good track record**
- **Site selection is important and early contractor involvement is required to ensure the site and particularly the underlying road layers are adequate to ensure long term durability**
- **These products must be installed by a well trained and qualified workforce. It is imperative that local authorities ensure their contractors have properly trained and qualified operatives ideally with an NVQ level two and all have appropriate CSCS and CPCS cards to ensure both good workmanship and safety.**

**Summary**
Grouted macadams have been in use throughout the UK for over 40 years and even longer in France. They have a long history of proven use and provide an alternative to conventional asphalt surfacings mostly where the site is particularly challenging and offers up problems which conventional asphalts are unable to deal with. They are proprietary products although some have HAPAS certification thereby giving the client third party assurances on quality and performance. The durability is very much dependent on ensuring the correct variant is selected and installed correctly by an experienced contractor with a good track record in this specialist field. It is not a technology that should be undertaken and installed by just any asphalt surfacing contractor.

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Geosynthetics and steel meshes for longer life pavements

Cracking in asphalt pavements is now recognised as one of the biggest problems faced by highway maintenance engineers. Geosynthetics and steel meshes, also known as interlayers, are a proven approach for extending the life of pavements. The RSTA explains why

When placed between bituminous bound layers these products retard the initiation and propagation of reflective cracking which leads to premature pavement failure.

These systems have a long track record of successful use with over five million m² used in the UK and more than 100 million m² installed throughout Europe since the 1980s. Over this period the industry has continuously improved its products, systems and installation techniques and captured evidence of performance. It is worth noting that the majority of UK local authorities have now used these systems as they have grown in acceptance.

The RSTA has produced a code of practice on these systems which has been peer reviewed and endorsed by ADEPT to provide highway authorities, designers and principal contractors with essential guidance on the use of geosynthetics and steel meshes, their use, laying techniques and applications. The document is freely available at www.rsta-uk.org/publications.htm and provides essential guidance on; material types, QA, site selection and material selection, training, traffic management and it also contains an extensive glossary of terms and references.

The maintenance of roads in the UK has always been a challenge due to heavy trafficking and variable weather conditions. Many types of treatments at, or below, the surface of an asphalt road have been used to extend the lifetime of the road with a view to minimising maintenance costs. Breakdown of the road surface is caused by weathering, movement and fatigue, accelerated by the asphalt’s susceptibility to reflective cracking leading to ingress of water, then to potholes and finally, a total breakdown of the surface.

One of the treatments which has been used extensively over the past 25 years in the UK and throughout Europe is the use of an interlayer which is installed within the pavement to intercept the path of a crack propagating through the road.
pavement. These interlayers are usually supplied as a rolled product in grid form (polymer, glass and steel mesh), non woven geotextile (polymer & glass) or a composite and non woven (both glass and polymer). This approach has resulted in significant whole life cost savings through reduced maintenance.

**Benefits**
The main advantages include:

- Maintenance cost reduction
- Significant extension of road life over conventional surfacing
- Reduction in asphalt thickness, in some circumstances, saving on material costs
- Reduced environmental impact associated with longer maintenance intervals
- Reduced hidden costs to businesses and the general public through delays caused by road closure and traffic restrictions.

These benefits have steadily driven increased utilisation of these products over recent years.

**Performance**
Bituminous bound layers crack in-situ because of their inability to withstand strain, shear and tensile stresses created by a number of factors resulting in one or more of the following outcomes:

- Reflective cracking
- Fatigue cracking
- Differential settlement (often prevalent in road widening schemes)
- Thermal cracking.

The effectiveness and performance of the geosynthetic or steel mesh system is highly dependent on site specific circumstances. The majority of UK pavements have evolved over time and were not originally designed to withstand the weight and increased traffic volume of commercial vehicles. It has taken many years of careful monitoring to establish the performance of these systems after accounting for the many variables that can influence pavement deterioration, and this work continues.

To obtain the best performance it is necessary to consider a range of variables and based on these carefully select the correct geosynthetic or steel mesh system. Research over the years has addressed and isolated these variables, either through laboratory or site trials and this work has been supplemented via extensive practical experience gained from many thousands of successful installations.

One key lesson learned and, often overlooked in the past, is that correct installation of these materials is an absolute necessity. It is imperative that geosynthetics and steel meshes are installed correctly and efficiently to maximise long term performance against reflective cracking. Improvements have been made to the efficiency of the installation by using trained operatives and the correct laying equipment generally resulting in little or no delays to the road surfacing installation. The code of practice has an extensive section on installation techniques to ensure the optimum performance of the selected system.

The type of damage mechanism causing the cracks to appear at the pavement surface depends on the properties and
### Product types

Key product types available are listed below:

#### Steel meshes

Steel meshes typically galvanised steel wire, double twisted to form a mesh with reinforcing bars at intervals.

#### Polymer grids

Polymer grids typically punched and stretched polypropylene or knitted/woven polyester. Other polymers are also available but less prevalent.

#### Non-woven textiles

Non-woven textiles are typically needle punched polypropylene but polyester and combination using glass fibres are also available.

#### Glass grids

Glass grids are typically knitted and may be coated with polymer or bitumen or a combination. Some of these materials have self adhesive backing.

#### Composites

Typically a combination of polymer or glass grids and non-woven textiles combined by lamination or stitching.

#### Geosynthetics and steel meshes

Geosynthetics and steel meshes must be compatible with the asphalt to ensure the integrity of the system. They must be stable and durable both to withstand the rigors of the paving operation and provide functionality for the desired design life.

The code aims to guide and inform designers and end users on the range of products and applications that are available so they are able to make informed project related decisions. It identifies the important aspects for the use, design and correct installation of geosynthetics and steel meshes in bound pavement layers.

### Quality assurance

All the product types listed in the panel above should be CE marked in accordance with BS EN 15381:2008 to ensure long term performance. The RSTA geosynthetics and steel meshes sector members are fully committed to the utilisation of quality manufactured products and operate quality management systems in accordance with the requirements of BS EN ISO 9001 (2008).

### Installation

Installation of the geosynthetic or steel mesh will usually be scheduled to take place immediately prior to the asphalt surfacing. Provided an experienced specialist sub-contractor has been selected, installation of the product should not normally delay the surfacing works.

### Training

All contractors site operatives must hold an appropriate CSCS card to demonstrate they have been properly trained and qualified to install the required product. Training requirements are embodied within the National Highway Sector Scheme 13 which stipulates the minimum training and qualification requirements for operatives and supervisors on site.

### Surface dressings reinforced with geosynthetics

Since the 1990s non-woven geosynthetics have been used in combination with surface dressings to treat roads that are suffering from reflective cracking. This provides an alternative economic solution to replacing the asphalt surfacing. New industry guidance on this topic was published in 2014 available from www.rsta-uk.org/publications.
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Filling the cracks

An explanation of crack sealing and joint repair systems for road surfaces

Over the past few years a number of crack sealing and joint repair systems for road surfaces have been developed to repair and reinstate the road surface in a safe and serviceable condition, to protect the road surface from premature degradation and hence enhance pavement service life.

The RSTA has published a new code of practice (2013) on these systems to assist procurers and installers on how to obtain high quality installations. This new guide represents best industry practice for the selection and application of crack sealing and joint repair systems to maximise their performance and durability. To ensure client side acceptance it has also been peer reviewed by the Association of Directors of Environment, Economy, Planning & Transport (ADEPT).

Crack sealing and joint repair systems are essential to:

- Reduce water ingress into the pavement surface and sub-surface layers
- Reduce pavement damage by hydraulic pumping and freeze/thaw action
- Reduce erosion by tyre interaction with a damaged surface or open joint
- Reinstate the road surface to its original profile
- Maintain skid resistance and texture depth.

To obtain the best results it is necessary to give careful consideration to the deterioration method, the traffic density and whether movement is present, before selecting the appropriate product. There are a number of HAPAS approved systems now available and the Guidelines Document for the Assessment and Certification of Crack Sealing Systems for Highways, Figure 1, October 2010 is reproduced below and overleaf:

Types of products and repairs

Products generally fall into two broad categories:

- Cold applied thermoset resins e.g. methyl methacrylate (MMA)
- Hot applied thermoplastic resins and/or bituminous materials.

There are three main types of repairs shown below and overleaf:

Grades within certificate categories

All three types of treatment can be described as either flexible or high modulus.

Flexible inlaid systems are categorised as Grade F and the stiffer high modulus systems are categorised as Grade H. Grade F should be used where movement is anticipated and Grade H where no significant movement is expected, but greater rutting resistance is required.

For overband and fill and overband systems the difference is not so well defined so the designer must consult the product’s HAPAS certificate before deciding which system to specify.

Fill and overband

Fill and overband systems are tested and approved for joints and cracks up to 40mm wide including; single part products with a single fill.

Overband

Simple overbanding systems for repairing joint or crack widths up to 5mm wide, with a finished bandwidth ≤40mm.

(Diagrams reproduced with kind permission of the BBA, from the Guidelines Document for the Assessment and Certification of Crack Sealing Systems for Highways, Figure 1, October 2010.)
Crack Sealing Systems for Highways (October 2010) describes four product categories: overband, fill and overband, inlaid single and inlaid multiple).

The code of practice identifies the important aspects of crack sealing and joint repair processes, provides guidance on the selection of the most appropriate treatment in each location and refers to other relevant documents to give practical guidance on achieving high quality.

Suitable applications

The presence of a crack or open joint in a road surface may be due to a number of factors which include:

- Thermal movement in the surface course
- Structural movement in the lower layers
- Lack of compaction/cold joints/lack of a vertical seal between adjacent asphalt layers in highway construction
- Lack of compaction/cold joints/lack of a vertical seal in utility reinstatements and highway patch repairs.

Left untreated, cracks and open joints in the pavement allow water ingress into the asphalt layers and ultimately into the pavement foundation. Water ingress, hydraulic pumping action and freeze thaw will all create further damage to the pavement and ultimately shorten the effective working life of the road surface.

Timely intervention using crack sealing and joint repair systems can both seal against the ingress of water and reinstate the surface profile, skid resistance and texture depth to acceptable levels to prolong the life of the pavement.

However, in order to select an appropriate system from those available, there are a number of considerations:

- What has caused the defect?
- If the sub-structure of the road has failed, then treatment of the surface course defect is unlikely to be successful over the long term. However, defects on the surface (thermal cracks and open joints) can be successfully treated and provide a long-term successful repair.
- Is the crack or joint still moving significantly?
- If the surface has been damaged by movement below from a predictable source for example reflective cracking through an asphalt surface course laid over transverse joints, then a repair should be undertaken that is capable of withstanding that ongoing movement.

If however a joint is open due to erosion and not to movement then a judgement must be made on which system to specify.

Service life

Regarding life expectancy HAPAS systems are classified as: >three years or >five years, but related traffic density is not specified. The system selected should reflect both the timescale required of the repair and the traffic density present on a particular site.

Where cracks have been caused by structural failure resulting in significant movement under traffic, it is not possible to predict a life expectancy for the repair. In structurally sound pavements where cracks or fretting joints are confined to the surface layer and not subject to further movement, the life declared in the system’s HAPAS certificate should be achieved.

In wheel track zones, particularly those subjected to heavy goods vehicles, the expected minimum life of a repair is unlikely to be exceeded, while those outside the wheel track zone may exceed it. On more heavily trafficked roads the expected service life of the system may not be achieved.

Inlaid single or multiple cracks

Inlaid systems are approved for single and multiple cracks. They are installed by planing out a required recess depending on the system’s specification. The product is then used to fill the recess flush to the surface and dressed with high PSV aggregate to provide texture depth and skid resistance.

![M42 crack infill](image)
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Patch repair systems

To the highway engineer patch repair systems offer a fast, efficient and cost-effective way of removing defects; safety hazards; maintaining skid-resistance; preserving and protecting roads against the damaging effects of water. To obtain the best results it is necessary to give careful consideration to a wide range of detail, to plan and design the work carefully. The speed of the patching operation and the short duration of time during which motorists are inconvenienced is also an important consideration and an advantage on roads carrying high volumes of traffic during peak periods. This article examines the different types of systems that can be used

There are two types of systems: Spray injection patching and thermal road repairs.

Spray injection patching uses high volume low-pressure air to clean the road surface defect before applying a bituminous bond coat of either a hot or cold bitumen emulsion. Aggregate is then propelled, using high volume air at low pressure, before mixing it with the bitumen emulsion moments before it is compacted as it is placed in the patch. For heavier trafficked applications, compaction by a vibrating plate is often used. The new repairs can then be trafficked immediately after laying. The process is also included in BS 434-2:2006.

Thermal road repair involves applying heat to the upper 20-30mm of the surface course of a defective area to soften the material so it can be easily reworked with any extra materials added prior to compaction. The compaction of the heated materials creates a homogenous bond between the repair and the adjacent surfacing.

Determining the specification

All innovative patching materials and processes can be specified in accordance with clause 946 www.dft.gov.uk/ha/standards/mchw/index.htm and also the HMEP Clause 946SR in Guidance for the Development of Standard Specification and Standard Details for Local Highway Maintenance Contracts Version 1.

The selection of the right type of patching techniques to be used in highways maintenance depends on the depth and the type of defect. Each site must be considered in the light of its unique characteristics, including nature of surface, geography, volume/speed of commercial and other traffic using the section of road.

Spray injection patching technical details

Examples of typical spray injection patching machines are shown below:

Typical materials used are:

- **Binders** - used for spray injection patching are cationic bituminous emulsions complying with the requirements of BS EN 13808. Spray injection patching machines generally use either 60 or 70 per cent bitumen emulsion bond coats, applied either hot or cold. Some emulsions are available in summer and winter grades. Consideration should be given during the planning stages of the programme to traffic volumes, road type, skid resistance requirements, weather, and future resurfacing plans as these may all affect the binder selection.

- **Aggregates** - must comply with BS EN13043 and are selected dependent on end use, in particular the site’s PSV requirements. The designer of the spray injection patching asphalt mixture shall select suitable aggregate sources and sizes to ensure the installed product will be durable.

Site suitability

The spray injection patching process is satisfactory for use as a semi-permanent road repair to highway defects such as potholes, haunching, cracks and crazing and pre-surface dressing patching. It is particularly suitable for remedial works to the rural network.
Installation
Spray injection patching produces material in a continuous controlled operation and should only be installed by fully trained and NVQ qualified operatives and supervisors. National Highway Sector Scheme 13 (NHSS13) for the supply and installation of surface treatments onto road surfaces now includes spray injection patching. If a contractor is registered to NHSS13 it means the workforce have been properly trained and qualified and are competent.

Traffic management and weather considerations
The spray injection patching process requires appropriate traffic control as and when deemed necessary by the highway authority or as a result of a risk assessment by the contractor. This shall be carried out in accordance with National Highway Sector Scheme 12.

Traffic should be carried out when the road temperature is 5°C and rising and below 45°C depending on the binder being used. Work should not be undertaken during periods of rain. However, it is possible to commence works on a damp substrate subject to spray injection patching guidelines being met.

Preparation
High volume air is used to remove all dust and debris from the area to be repaired before an application of bond coat is applied to seal the treated area. Road preparation is important to avoid de-bonding failures. Mechanical sweepers are used to clean the road surface before works are carried out. In extreme conditions such as heavy soiling additional measures may be required including the removal of loose material, vegetation, moisture and debris to the defect.

Compaction
Compaction is not normally necessary as material self-compaction is part of the process however it may be required on more heavily trafficked roads. Loose chippings larger than 6mm can cause vehicle damage and should be removed as soon as possible following treatment by light sweeping.

Method of working
The spray injection patching machine size and type is of major importance in assessing the following, due to the varying machine configurations available on the market.

On single carriageway trunk and principal roads, spray injection patching falls into the category of “mobile works”. Under this type of working, traffic will be controlled by the use of stop and go signs. The length subjected to this operation should be kept as short as possible consistent with safety requirements. Experience suggests that the safest method of operation is to treat one half of the road for the total length of the section. Traffic should be controlled to allow all plant and equipment to turn safely and position itself to treat the second half of the road. On minor roads, a decision will be required at the initial planning stage as to whether or not the road is to be treated in one pass.

Where the whole width is not to be treated in one pass and one way traffic operation past the spray injection patching process is contemplated, it is essential to ensure that the width of road available to passing traffic is not less than the desirable minimum of 3.25 metres or the absolute minimum of three metres set out in paragraph 2.5.16 of Chapter 8 of the Traffic Signs Manual.

Limitations of the process
Understanding the limitations of the spray injection patching process is key to the success and quality of the repairs carried out. Contributory factors for repair failure include:

- Incompatible material selection
- Operatives not trained and competent
- Repair mixture outside of specification
- Inclement weather immediately after application
- Incorrect process selection
- Road and air temperatures too high or low
- Quality control checks not carried out
- Aggregate contamination either on delivery or once delivered
- Binder outside of specification
- Lack of compaction where required.

Addition of bitumen emulsion and asphalt
The bitumen emulsion bond coat should be introduced into the air stream enabling it to be forced into every crack and crevice to improve the adhesion of the bond coat while at the same time sealing the repair and the road base from further water damage.

The bitumen emulsion and an approved aggregate are delivered by the application tube, then immediately sprayed into the void at high speed. The new material is keyed into the existing surface.

Thermal patch repairs technical details
The thermal repair process is regulated under the HAPAS product approval scheme. It is a permanent road repair system for surface course defects that involves re-heating and recycling the existing in-situ material using a thermal heater.

Additional materials are added when necessary to facilitate the repair of the road surface.

- Bitumen emulsion – a proprietary bitumen emulsion, mixed into the re-heated surface before compaction
- 0/6 mm or 0/10mm asphalt – two proprietary bitumen emulsion asphalts, mixed into the surface before compaction to ensure finished surface levels are restored
- Coated chippings – the types and sizes of coated chippings is determined by the site-specific requirements, including location and contractual requirements for polished stone value (PSV); texture depth and/or other properties of the existing surface course.

The products used are:

- Bitumen emulsion
- 0/6 mm or 0/10mm asphalt
- Coated chippings
Application and installation
Thermal road repair system is satisfactory for fixing defects such as potholes, chipping loss, joint failures, consequential damage and surface cracks on asphalt surfaces.

The system is installed solely by contractors approved by the HAPAS certificate holder using specialised equipment in accordance with the certificate holder’s laying procedure.

This should be in accordance with Department for Transport Traffic Safety at Street Works and Road Works Code of Practice and the following regulations:
- The Health and Safety (Safety, Signs and Signals) Regulations 1996

Works should be suspended during periods of continuous or heavy rain. Any free-standing water should be brushed away from the area prior to repair. The system should not be used when the air temperature falls below 0°C in anything other than calm, dry conditions. Use of the system should cease in all conditions when the air temperature falls below -3°C.

Preparation
The defective road surface is heated using the thermal heating equipment. Once the heater is removed the material temperature is then measured and recorded.

When the surface has been heated to the required temperature, a joint of 50mm inside the perimeter of the heated area is cut into the surface by hand.

For heavy deterioration, thermal road repairs may be used as a short-term fix pending a permanent solution

The surface is then raked thoroughly to expose the maximum surface area within the material.

When necessary, bitumen emulsion is applied to the heated surface and raked in thoroughly with the existing material, prior to compaction. The addition of the emulsion is dependent upon the visual condition of the asphalt at the time of the repair. Additional asphalt mixture is added when necessary to ensure satisfactory finished levels. When required, coated chippings are applied to the surface taking care to ensure the finished texture level is achieved.

A temperature reading is taken of the repair to ensure it is between 80°C to 90°C and therefore ready for compaction.

Compaction and after care
Thermal road repairs are fully compacted immediately using conventional compaction equipment.

Visual checks for uniform surface texture, blemishes and any discernible faults are conducted by the installer and any remedial works carried out as necessary.

During the cooling period no disturbance or trafficking of the system is permitted. The repair can generally be trafficked within an hour.

Joints, binders and aggregates
The process provides a permanent seamless repair thus avoiding weak joints being formed. Thermal repairs can be undertaken across the pavement and do not have to avoid the wheel tracks of vehicles.

Binders used for thermal road repairs are proprietary bitumen emulsions and must comply with the requirements of BS EN 13808.

Aggregates shall be chosen from the appropriate properties and categories in BS EN 13043 aggregates for bituminous mixtures and surface treatments for roads, airfields and other trafficked areas.
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Experience - the difference
**Maintaining skid-resistant roads**

An explanation of why surface retexturing provides a quick, efficient and cost-effective way of maintaining skid-resistant road surfaces

**To obtain the best results it is essential to ensure the correct retexturing technique is employed and to plan the work carefully.** The speed of the retexturing operation and the short duration of the works help to minimise road user delays and provides a significant benefit to both clients and motorists.

The purpose of retexturing is to restore adequate levels of micro and/or macrotexture and thereby skid resistance. This latter quality plays a major part in crash/collision reduction and was highlighted by the initiative of the Department for Transport in 1987 when the Minister introduced minimum mean summer SFC values for motorways and trunk roads. The importance of surface texture has been highlighted by TRL Report LR 286, which stresses that texture depth is important under both wet and dry conditions.

Current guidance is available in the Design Manual for Roads and Bridges (DMRB): Volume 7 Section 5 Part 2 - HD37/99. However, the Highways Agency are currently revising parts of the DMRB so retexturing may end up in HD32 (Maintaining Concrete Roads) and HD31 (Maintaining Asphalt Roads).

A number of retexturing techniques are identified in the current DMRB as follows:

- **Bush hammering**
- **Shot blasting**
- **Grooving/grinding**
- **Longitudinal scabbling**
- **Orthogonal grooving**
- **Carbonising**
- **Water jetting**

More recently a new technique has entered the market called fine milling which removes a shallow depth from the road and in doing so effectively re-profiles the surface.

There is clearly a range of techniques available and it is vitally important for the correct treatment to be specified to deliver the correct end result. Secondary sweeping may need to be implemented several days after the initial treatment and traffic management may be required for difficult or potentially dangerous sites.

**Quality assurance**

Retexturing contractors have traditionally operated to first party quality assurance schemes. However following the recent inclusion of retexturing techniques within National Highway Sector Scheme 13 contractors are now required to become certificated to BS EN ISO 9001.

**Treatment selection**

It is essential to choose the correct retexturing treatment when planning to restore surface characteristics to ensure that the existing surface can actually be treated and that the required level of skid resistance can be restored for the required length of time. Choose the right technique and it is likely that the process can be repeated again when required at the same location and on the same surface.

It is important to note that retexturing will not cure any underlying problems within the pavement structure and in these circumstances it should be regarded as a temporary holding measure until a permanent solution can be undertaken.

Whilst process specific specifications are usually available, it must be remembered that the resulting treatment can only be as good as the surface that is being treated. It is only improvements in texture - micro and macro - that will be achieved, not improvements to the condition of the surface course itself. Where the aggregate in the existing surfacing is not capable of resisting the polishing action experienced at that site then the restoration of skid resistance will only be temporary.

Treatments that remove surface matrix must be used with caution, particularly on ageing surfaces, to ensure aggregate support is not removed. Treatments that impact the surface must similarly be well controlled - too great an impact pressure may potentially dislodge surface aggregate.

Accordingly, the resulting improvements can be measured by texture depth and/or surface friction measurements. Contractors must assume full responsibility for the quality of the work undertaken and to apply their experience to deliver the best possible outcome. Clients can specify at the outset what they are looking for in terms of improvement, essentially clients can specify end-product performance, but must be realistic in their expectations.

There should be early contractor involvement between contractors and their clients, the purpose of which is to ensure total understanding of what the individual treatments provide.

Guidance on the range of retexturing treatments available can be found in Table 11.1 ‘Appropriate circumstances and treatments for retexturing bitumen-bound surfacing’, in the DMRB Volume 7 Section 5 Part 2 HD37/99.

Additionally, as with all specialist highway maintenance processes/techniques, the quality of the treatment is totally dependent upon the effective maintenance and condition of the plant and equipment along with the relevant training, knowledge and skills of the operatives. This should be supported by good company management and relevant experience.

It is also important that clients inspect/measure sites immediately before and after treatment, supported by appropriate testing, to ensure that they achieve the desired result.

The following are some of the factors the client should consider in selecting the appropriate treatment:

- **It is essential to make the right choice - all retexturing processes are not the same**
- **Assess the suitability of a particular retexturing process and the type and condition of the existing road surface - what needs improving, microtexture, macrotexture or both?**
- **Assess the potential weather implications, not all processes are weather independent**
- **Bear in mind that any treatment which is unable to follow the profile or contour of a surface precisely and unable to cope with surface deformation may leave untreated areas with low skid resistance**
- **Restoration of microtexture is fundamental if optimum levels of skid resistance are to be achieved**
- **Restoration of macrotexture becomes increasingly important - in addition to micro texture – as vehicle speeds increase**
- **Ensure a consistent retextured finish has been achieved across the full treated width**
- **Seek professional advice.**

Mechanical and/or pressure wash sweepers can be used as appropriate to clean the road surface after retexturing is carried out.
Retexturing techniques

Impact methods
Processes in this category involve striking the road surface with either hard-tipped tools or hard particles (steel shot) to effectively improve skid resistance and/or texture depth. These processes are effective where the loss of skid resistance is mainly due to polishing of the aggregate particles and include the following techniques:

Bush hammering
The bush hammering process involves a number of independent fully controlled treatment tips which mechanically restore skid resistance to any existing surface. The technique is applicable to all road surface types including surface dressings, asphalts, e.g. hot rolled asphalt, thin surfacings, and concrete. This treatment improves and restores microtexture by re-profiling aggregate to recreate the original sharp angularity of the aggregate and removing polished particles and fines. Macrotexture will also be improved depending on the surface. This technique follows the surface profile and can cope with surface deformation and variations in road width, using instant variable width control, providing a consistent and even skid resistance to the treatment area. The surface levels of the treatment area remain the same as the surrounding surface and the treatment is repeatable. The treatment causes no damage to joints/repairs and traffic loops. Road markings, road studs and ironwork do not need to be removed prior to treatment and can be avoided if necessary. The process can be used in any weather conditions and equipment is available to treat large and small areas.

Shot blasting
Abrasive blasting is effective in removing surface polish, giving an improvement in micro and macrotexture. Shot blasting involves graded steel shot being projected at high speed and at an optimum velocity from a rotating wheel. The technique improves surface texture by abrading and re-profiling aggregate and removal of bituminous matrix, fines and detritus. Equipment is available which is suitable for treating both large and small areas including different blast head widths. The treatment causes no damage to joints/repairs and road markings and road studs do not need to be removed prior to treatment. The surface levels of the treatment area remain the same as the surrounding surface.

Microtexture is improved by cutting through the surface aggregate and exposing new aggregate faces, creating a corduroy effect Depending on the surface initially surface texture depth can also be improved by creation of longitudinal grooves but the process can also reduce texture depth.

Grooving/grinding
a) Longitudinal grooving/grinding:
Grinding with longitudinal grooving (following surface profile) involves the creation of longitudinal grooves using diamond tipped saw blades. The closely spaced saw blades cut grooves at a predetermined width and depth and this process follows the profile of the surface. The surface levels of the treatment area remain the same as the surrounding surface and the treatment is repeatable. This technique improves microtexture and macro-texture and has the potential to reduce tyre/road noise. The treatment causes no damage to joints/repairs and road markings, road studs, ironwork and traffic loops do not have to be removed prior to treatment.

b) Transverse grooving/grinding:
Uses diamond tipped blades and pressure washing to remove slurry. It can be used to provide discreet grooving patterns and can aid surface water drainage (has little effect on skid resistance) and can lead to increased tyre/road noise levels.

Both processes can be used under wet conditions.
**Fine milling**

Fine milling (following surface profile) involves the creation of longitudinal grooves using tungsten tipped cutting tools set at 6mm spacing. The machine has accurate level control and removes the top 2-6 mm of the road to achieve a new running surface. This can also be used to provide a key for an overlay treatment. The cutting drum can adjust the number of revolutions per minute to alter the texture depth in different surface materials. In reducing the overall level of the surface, all cats eyes and street furniture need to be removed or reset. The technique is fast and improves microtexture and macrotexture, thereby improving skid resistance and increasing texture depth. It can be used under all weather conditions.

*The DMRB is available from [www.standardsforhighways.co.uk](http://www.standardsforhighways.co.uk)*

**Fluid action**

These systems are not mechanical reworking of the road surface, they are effective removal/cleaning systems:

**Water jetting**

This process involves the controlled jetting of water through a series of nozzles at high pressure onto the road surface. It does not restore skidding resistance lost through the polishing action of the traffic. It thoroughly cleans the surface and removes surface contaminants and rubber deposits to expose and improve the existing macrotexture (below: HRA before and after treatment).
In-situ road recycling for cost effective highways maintenance

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In-situ road recycling

How can recycling be beneficial in road maintenance?

In-situ road recycling is not only an economical solution to road pavements in need of reconstruction but is also well suited to the rehabilitation of pavements that are contaminated with ‘tar’. Tar is derived from the distillation of coal in the production of domestic ‘town’ gas and was widely used in UK road building from the mid 1800s. ‘Tar’ is a possible carcinogen and is therefore considered hazardous. In-situ recycling is acknowledged as being the preferred method of dealing with ‘tar’ residues in road construction in that the resultant recycled mix encapsulates the hazardous contaminants, rendering them harmless to the environment and avoids the need to treat tar as hazardous waste.

The structural maintenance options available to the highway engineer will vary depending on the amount of funding available and the physical constraints of the site. Some sites may have structurally deteriorated to a ‘critical’ condition so that full depth reconstruction is considered the only option available whereas others may be deemed to be less serious and may therefore be strengthened by the provision of a substantial overlay or inlay.

The purpose of in-situ recycling is to effectively restore a failed road pavement by recycling and reusing the existing construction materials to construct a new pavement with strength and life expectancy that is equal to that of a traditionally designed and reconstructed pavement. The need to dispose of huge volumes of waste materials, import processed virgin aggregates and hot bituminous bound material is greatly reduced resulting in a lower carbon footprint overall. Structural road recycling can often be a cheaper and more effective solution in both the urban and rural situation by virtually eliminating accommodation works and by providing a 20 to 40 year design life with a construction which is non-frost susceptible regardless of site conditions or constraints.

Depending on the design traffic predictions for the pavement and the severity and nature of the structural failure a recycling solution may require recycling thicknesses ranging from 125 to 325mm with additional overlay requirements of between 45 and 160mm. The structural design of a recycled pavement can be adjusted in accordance with TRL Report 386. To ensure quality assurance contractors operate to BS EN ISO 9001 Quality Management Systems.

Site suitability

It is essential to prove the strength capability of the processed material and to demonstrate its suitability for the application proposed. There are four main elements that determine site suitability:

- **Cause of failure of an existing road pavement**
- **Proposed design traffic in Million Standard Axles (MSA)**
- **Suitability of the existing pavement materials**
- **Underground utilities**

TRL 611 or TRL 386 states that recycled roads can be expected to carry up to 80 million standard axles (MSA).

The specialist plant needed can process widths from one metre to full carriageway whilst the machines themselves vary in overall width between 1.6 to 3.1m. Road recycling can be carried out under a range of different traffic management options including full road closure (generally considered the safest, quickest and cheapest) or half width working under temporary traffic control or ‘one way’ system configuration.

Ex-situ recycling requires a mobile plant to be installed near to the site therefore it is important to identify a suitable compound (often a field or car park) typically 2,000 m² in area with safe access for HGVs.

The process requires large volumes of water to hydrate the hydraulic binder in the mixture and also to control moisture content in the mixed material. Up to 60,000 litres of water may be required to complete each day’s work so local water supplies need to be identified prior to tendering to avoid increased costs from importing water long distances by road.

Statutory undertaker’s appliances within the proposed recycling layer may prevent the process from being used particularly on urban sites. It is important a ground radar survey is carried out at an early stage so any offending apparatus can be located and a judgement made.

Drainage improvements may need to be carried out prior to the recycling works commencing in order to ensure that the life expectancy of the repaired pavement lives up to the theoretical design life.

The set-up costs are relatively high in comparison to traditional reconstruction as the process requires specialist plant and a highly trained labour force. Only a small number of contractors have the necessary specialist plant and expertise to carry out these projects. Larger schemes of a 3,000 m² will show the greatest cost savings and environmental benefit. ☺️
Site investigation

All sites to be considered for treatment should be properly investigated and the materials recovered and tested in accordance with TRL guidelines prior to acceptance for treatment.

Most materials found in UK roads are suitable for treatment including successive layers of asphalt and bituminous bound macadam, tar bound macadam or granular materials contaminated with tar, granular sub-base, burnt colliery shale, quarried scalings (maximum size 100mm), soft sandstone pitching and brick hardcore. There are however some materials that cannot be treated including oversized hard stone rock including granite sets, large pitching/capping rocks, pavement quality concrete, organic peat and some clay deposits.

Trial pits should be excavated at a maximum frequency of one trial hole per 800–1,000 m² providing that materials and depth of construction found are broadly similar.

Specification

Road recycling is covered in the Specification for Highway Works clause’s 947 and 948 and in TRL 386 or TRL 611 and referred to as cold recycled bound material (CRBM).

Which binder to use depends on many factors including funding restraints, environmental considerations, traffic usage, sub-grade CBR and any other underlying ground conditions. The application of lime may also be required initially in order to modify cohesive sub-grade soils that will be incorporated within the recycled roadbase/binder course layer in order to satisfy the structural design requirements of the site.

TRL 386 contains a useful flow chart which helps the engineer decide whether road recycling is a viable option for a site under consideration and which binder option to use.

Most in-situ road recycling schemes have used either quick hydraulic (QH), medium hydraulic (MH) binders or quick visco elastic (QVE) foamed bitumen binders.

Schemes are usually designed by the recycling contractor then approved and adopted by the engineer in charge of the works. The guarantee period is usually 12 months from completion.

Road preparation

It can be necessary to pre-plane the road in advance of the works in order to maintain levels and thresholds.

All recycling schemes require the application of at least a new surface course and this together with a degree of bulking caused by the recycling process will mean that if thresholds are to be maintained then some material will have to be taken away from the site.

Binders

There are five main binder categories used in road recycling:

- **QH – Quick hydraulic**
  Portland cement (PC) as the main hydraulic component.

- **SH – Slow hydraulic**
  Binders such as pulverised fuel ash (PFA)/lime or granulated blast furnace slag/lime but excluding bituminous binders and PC.

- **MH**
  A medium strength gain hydraulic binder containing both PC and PFA thereby offering the advantages of both QH and SH binder categories.

- **QVE – Quick visco-elastic**
  Bituminous binder as the main component but also including PC.

- **SVE – Slow visco-elastic**
  Bituminous binder as the main component but excluding PC.

Installation

It is a requirement of the specification that a UKAS accredited laboratory technician attends the site throughout each stage of the process fully briefed as to the sampling and testing regime required.

With urban sites all ironwork within the pavement to be treated should be lowered to a level at least 100mm below the proposed treatment depth wherever possible.

With rural sites it is important that the drainage is improved in advance of the works where practical to help achieve the expected service life of the road pavement.

It is essential that after the pulverisation stage but prior to the mixing stage the granulated material is levelled and graded back to a similar shape and level to the original road surface. This is necessary to ensure that the correct depth of treatment is achieved and the correct amount of binder is added throughout the course of the works.

The moisture content of the pulverised material should be measured and recorded immediately prior to stabilisation and any necessary adjustments made to achieve + or - 2% of optimum either prior to treatment by aeration or during mixing by the addition of additional water through a computer controlled pump and spray bar on the recycling machine.

The addition of both bituminous and hydraulic binders demands great care to make sure that the resultant mixture compares favourably with the job standard mixture.

Once grading is complete final rolling can take place, usually involving two or three passes of the roller in vibration mode.

Following compaction the treated surface is sealed with a K140 bituminous emulsion. A lightly coated bituminous grit should then be applied immediately on to the bituminous tack coat layer at a rate of 5.5 – 7.0 kg/m² to provide a non-stick surface for public vehicles, pedestrians and construction traffic and to facilitate the curing of the recycled layer.

Road recycling should only be carried out when the air temperature is ≥ 3°C and rising.

Stringent level control for an in-situ road recycling scheme
Aggregates and fillers
It is rare that additional aggregate or fillers are required. PFA on occasion is used as a filler to correct inadequacies in material grading.

Compaction
Compaction should be carried out with a twin drum vibrating roller with a minimum dead weight of 10 tonnes. Vibration mode should be used at all times. Each pass of the roller should be overlapped by at least 100mm and a defined rolling pattern should be adhered to.

Aftercare
The treated area can usually be trafficked two hours after completion and straight line trafficking is often encouraged. This usually applies to all binder categories except SVE which normally requires a 24 hour period for curing.

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Asphalt preservation provides an efficient and cost effective treatment method for protecting road surfaces against the effects of weather and oxidation thus prolonging the life of an asphalt pavement. In nearly all cases the application of asphalt preservatives requires minimal plant and personnel. This article explains more about the works whilst in progress. This same duty of care is equally as applicable to any aftercare operations.

The planning and organising for health, safety and environmental issues must be considered as soon as an asphalt preservation programme is envisaged. Asphalt preservation operations will be undertaken under the framework provided in the Construction Design and Management Regulations 2007 (CDM). Clients are urged to follow the advice in the relevant approved code of practice as they have the responsibility under the new version of the regulations for initiating safe working practices.

The CDM coordinator and principal contractor will plan and prepare the information and documentation necessary to ensure that specific hazards are identified on individual sites and the associated risks are managed effectively. This must take into account the nature of the site, the materials being used, the traffic management requirements and any special health, safety and environment issues that have become evident during the tender stage.

The client should employ a competent and approved contractor. It is recommended that the simplest way for a client to achieve this is to select at tender stage contractors registered to National Highways Sector Scheme 13 as recommended in the Specification for Highway Works. Once the contractors have been selected, the pre-construction information contained in the tender document should be detailed enough for the prospective contractors to take account of the health, safety and environment issues in their tender submission.

All preservation products are dispersed within a carrying agent which can be water or solvent based. For product specific information contact the contractor/installer.

Quality assurance

The RSTA recommends that the application of these products is undertaken by installers registered with or working towards National Highway Sector Scheme 13.

Products used for asphalt preservation must be manufactured under BS EN ISO 9001.

Additionally asphalt preservation treatments can be independently certificated under the Highway Authorities Product Approval Scheme (HAPAS) or equivalent.
Planning and coordination

Careful and detailed planning before work commences is an essential element of successful asphalt preservation. There needs to be close coordination between contractors and their clients at every stage, commencing with a pre-works meeting, the purpose of which is to ensure total understanding of the way the programme will proceed.

Planning will also assist in budgeting correctly for the projects. Where possible accurate measurement of the area to be treated should be made and agreed by the client and the contractor in advance of the works.

Site suitability

Preservatives should be used to preserve the road surface in the condition it is in at the time of application. They cannot improve a road surface.

In deciding whether asphalt preservation is appropriate for a particular project, it is necessary for the end-user to understand what needs to be achieved by the application and the limitations of the product.

For example the client may consider the adoption of an ongoing preservation strategy starting at the construction stage to help maintain the new surface course condition for as long as possible.

The system installer must be involved in site selection to determine the appropriate treatment.

Surface binder composition

Asphalt preservatives will work on bituminous bound surfaces only. If the surface is non-bituminous then asphalt preservation is not appropriate.

Site location

Where available the local authority should provide site information to the installer referring to texture and skid resistance. All treatments are seasonal and should be typically applied between April and September.

Skid resistance

It is important that current skid resistance data is available when considering the application of a preservation treatment to a high-speed road.

Preservatives should only be considered where readings are adequately above the relevant investigatory level/s as there is usually a temporary decrease in skid resistance post application. However, the skid resistance levels will return to their original values, the rate of this is proportional to the site’s traffic levels. The installer will determine if additional measures are needed to maintain adequate skid resistance.

If the skidding resistance is at or below the investigatory level then the road surface will need to be pre-treated to restore adequate skid resistance before applying a preservation treatment. There are a range of re-texturing processes available that may be suitable as a pre-treatment.

Site preparation

The amount of site preparation required will depend on the condition and nature of the existing surfacing course.

Any surface defects identified must be repaired before using a preservation treatment e.g. sealing cracks, filling open joints, repairing potholes, patching. The road surface must also be swept and clean before treatment.

Treatments

There are two types of preservation treatments, penetrative and non-penetrative.

Penetrative treatments are solvent based and as such soften the existing surface on application to facilitate some penetration of the binder coating. They comprise a blend of bitumen and/or, hydrocarbon resins, diluents, plasticisers and may be fortified with natural based bitumen.

Non-penetrative treatments are bituminous emulsions. They comprise of proprietary blends of bitumen, polymers and other additives designed to seal and protect the road surface.

Post application and aftercare

The road can normally be re-opened to traffic after the preservative has cured (typically within one to two hours).
The Construction Industry Helpline provides support and advice on a range of topics from **occupational health** and **wellbeing** to **financial aid** in times of hardship caused by accident, illness or bereavement.

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Innovative patching products

The subject of innovative patching products explored

Innovative patching products (IPP) are specially designed and manufactured cold lay asphalts offering highway authorities an alternative to conventional asphalt patching products. They have the following characteristics:

- Relatively low operational cost
- Fast installation
- Minimal disruption to the road user
- Low carbon footprint
- Dependent on the type of repair may not require saw cutting and jack hammering so reduced risk of hand arm vibration and less waste produced
- Unlimited availability in bags and tubs with prolonged shelf life
- Available in bulk bags and open bulk loads

These products offer a fast, efficient and cost-effective way of repairing surface course defects (e.g. potholes) and safety hazards. To obtain the best results it is necessary to give careful consideration to a wide range of detail, to plan and design the work carefully. The speed of the patching operation and the short duration of time during which motorists are inconvenienced is also an important consideration and advantage on roads carrying high volumes of traffic during peak periods.

Cold lay asphalts are essentially asphalt mixtures manufactured using standard aggregates and bituminous binders mixed at elevated temperatures then allowed to cool to ambient prior to packaging in tubs or bags where required. They are cold applied materials used for temporary and permanent repairs. The new repairs can then be trafficked immediately after laying.

Quality assurance

All manufacturers of IPP are certificated to BSEN ISO 9001 Quality Management Systems by a UKAS accredited certification body and have a HAPAS certificate for their product.

All current IPP HAPAS certificates can be obtained from the BBA website www.bbacerts.co.uk

Determining the specification

All IPP’s can be specified in accordance with clause 946 in the MCHW Specification for Highway Works Volume 1 www.dft.gov.uk/ha/standards/mchw/index.htm and also the HMEP Clause 946SR in Guidance for the Development of Standard Specification and Standard Details for Local Highway Maintenance Contracts published by the DfT.

Product selection is mainly determined by the contractor based on the depth and the type of defect. Each site must be considered in the light of its unique characteristics, including nature of surface, geography, volume/speed of commercial vehicles and other traffic using the section of road. Some local authorities may decide to select a preferred product particularly on heavily trafficked roads where end performance is deemed to be a high priority. It should be noted these products are proprietary, should not be confused with traditional deferred set macadam and each product is supplied with adequate guidance to ensure appropriate installation on appropriate sites.

The required site information, planning and execution and traffic management is the same as for other surface treatments.
**Product description**

IPP’s or cold lay asphalts are available in different aggregate grades typically 3mm, 6mm, 8mm and 10mm to accommodate the need for varying repair layer thicknesses. These products contain a proprietary bituminous binder and graded aggregates to BS EN 13043: 2002.

Cold lay asphalts are generally supplied in pre-packed, ready to use, polythene bags or plastic tubs, one ton bulk bags and bulk open loads. The product packaging is stamped with the product name and aggregate size, weight, storage information, handling and usage instructions plus health and safety information. In addition, there is a batch number for traceability to the date of production. When stored correctly in the sealed container the product will have a storage life of at least three months in bags or six months in plastic tubs and in some cases in bulk open loads and one ton bags.

PSV requirement is site specific and is normally specified by the local authority as determined from the Design Manual for Roads and Bridges volume 7, section 5, HD36/06 Table 3.1. Cold lay asphalt products usually contain aggregate with a PSV above 60.

**Site suitability**

Cold lay asphalts can be used for temporary repairs and also as a permanent cold-lay surfacing material when formulated to give a performance equivalent to hot-lay materials. Cold lay asphalts are particularly suitable for reactive (Category 1 within 24 hours) or planned maintenance (Category 2 within 28 days) small works such as pothole repairs, street ironwork, repairs to footways, access covers and link boxes.

**Manufacture quality control**

Cold lay asphalt manufacture is regulated under HAPAS and manufacturers should also be registered to BS EN ISO 9001. The manufacture details are as shown on the product’s HAPAS certificate.

**On site storage**

Cold lay asphalts, bond coats including sprays and skid resistant over-banding tape, must be stored in cool, well-ventilated, dry conditions, protected from frost and high temperatures.

**Climatic considerations and surface preparation**

Cold lay asphalt repairs can be applied when air and road temperatures are between -5°C and 40°C.

The damaged area to be repaired should be marked out and the edges normally saw cut back to sound material. The prepared area should be regular in shape. For high-speed roads BS 434-2:2006 recommends a diamond shape. Note some product manufacturers claim saw cutting is not always required for their products.

Prior to patching the area should be cleaned and free from debris and contaminants such as loose materials and standing water.

In accordance with the Specification for the Reinstatement of Openings in Highways (SROH) some manufacturers recommend applying a bond coat to the vertical edge of the repair prior to compaction to ensure good bond is achieved when the cold lay asphalt is fully compacted. For ease of use, bond coats are now available in spray cans and brush pouring grades.

Prior to patching an area should be cleaned and free from debris.
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Compaction

The manufacturer will advise the contractor regarding how best to compact the cold lay asphalt, including surcharge, to ensure it is well compacted achieving a durable dense finish.

The material is compacted to the surrounding level using a suitable compactor/roller in accordance with the certificate holder’s instructions or Section S10 and Appendix A8 compaction requirements of the SROH.

The product must be fully compacted. Compaction must cease before migration of binder to the surface or crushing of aggregates is observed.

Installation of a HAPAS approved anti-skid thermoplastic over-banding system to the edges of the reinstatement is recommended by some manufacturers to seal and waterproof the joints.

On completion the installer should visually inspect the finished surface for uniformity and any discernible faults and remedy these if necessary.

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