ADEPT

ASSOCIATION OF DIRECTORS OF ENVIRONMENT, ECONOMY PLANNING AND TRANSPORT

# Guidance on the use of paving fabrics and grids as asphalt reinforcement

## Introduction

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This document provides guidance on the selection and use of various reinforcing and stress relieving systems to enhance the durability of an asphalt overlay in a cracked or vulnerable pavement. The products used are often referred to generically as geosynthetics and include a wide range of grids, fabrics, sprayed membranes, and combinations thereof. In this document, for convenience, the term Stress Absorbing Membrane Interlayer (SAMI)/asphalt reinforcement will be used. The range of product types covered is described in greater detail below.

HA in a draft IAN indicate that they are unwilling to accept the use of these materials to justify a reduction in depth in a designed pavement. However, properly used, they can provide considerable benefits in maintenance by prolonging the life of the pavement and hence substantially reducing the ongoing drain on the maintenance budget of sub-standard or non-engineered roads.

It has been the experience of a number of ADEPT members that the careful use of a SAMI/ asphalt reinforcement provided an increase in the life of overlays and hence reduction in the long term drain on resources such that, despite great restrictions in budget and increasing volumes of traffic, a stabilisation of the overall deteriorating condition of the roads in the area was achieved, and indeed, on occasion turned to an overall improving condition.

## Potential benefits of introducing a SAMI/asphalt reinforcement

The potential benefits include:

1. Reduction of propagation of reflective cracking;
2. Ensuring sound and uniform bond between the bituminous layers;
3. Sealing, thereby preventing water and air travelling down through and degrading the pavement and foundation layers;
4. Provision of tensile strength to reduce cracking and splitting of the pavement as a result of deformation under traffic over poor ground.
5. Reducing the tendency of excessive bitumen in old layers to migrate upwards and contaminate overlays.

Realisation of the benefits requires careful selection of the appropriate product type for any particular situation, followed by good quality control on site to ensure that the proper

preparation and laying procedure is followed. A number of product suppliers actually provide and may insist on specialist teams to lay the material, thereby ensuring the availability of the necessary expertise and appropriate laying equipment

It would be of particular advantage if it were possible to quantify the benefits listed above. However despite extensive and lengthy research this remains a difficult area. This is mainly because the quality of and movement in the existing pavement below the SAMI is so very variable and this, together with the SAMI system used and the thickness of and type of overlay has a significant effect on the subsequent performance and the time before further maintenance is necessary.

Asphalt surfacing materials that are fatigue and/or crack resistant will provide longer lives than stiff or brittle materials when used with a SAMI. The bitumen type and quantity in the asphalt overlay is the key determinant of this. Crack resistant Thin Surface Course Systems and Hot Rolled Asphalt Surface Course, and SMA and HRA binder courses are particularly suitable. The requirement for flexibility may conflict with the requirements for stiffness and rut resistance and this may have to be accommodated by the use of appropriate polymer modified binder and/or suitable mix design.

In considering whether to incorporate a SAMI/asphalt reinforcement it is sometimes useful to calculate the thickness of overlay which could be provided for the same cost, and then consider which will give the greater benefit, the SAMI or the extra overlay. It may be appropriate to carry out this exercise for a number of different product types. A number of suppliers have software which can assist in this consideration and the design process.

**Control Section**

In view of the need for increased data on the effects of SAMIs/asphalt reinforcement it is desirable to provide a control section in which the SAMI is omitted. It is then possible to monitor the difference in performance (if any) in those particular conditions of traffic volume, underlying ground, existing pavement construction, and overlay, and to see whether and by how much the time to next maintenance is extended. Without such a control section, one cannot say with any degree of confidence whether or by how much the SAMI in fact contributed to the subsequent performance of the overlay. In due course, data from such controls can build up into extensive knowledge based on sound experience.

**Types of SAMI/asphalt reinforcement available**

1. Grids, made from steel wire, polypropylene, glass fibre, or other synthetic material.
2. Woven fabrics
3. Non-woven or continuous monofilament needle punched fabric.
4. Synthetic grid bonded to a non-woven fabric
5. Sprayed rubber membrane with microasphalt protection layer.

Fixing methods vary; steel and some synthetic grids are fixed down by nailing or stapling to the surface, other synthetic grids are bonded to a self adhesive fabric, and fabrics may be self adhesive or laid in a bituminous bond coat. With some systems, the SAMI is completed by over-spraying followed by a protective layer of chippings.

The potential benefits for the various materials are summarised in Table 1

| System | Reduced reflective cracking | Enhanced bond between layers[1] | Sealing | Tensile strength[3] |
|---|---|---|---|---|
| Steel grids | Yes | No | No | Yes |
| Synthetic grids including glass fibre | Yes | No | No | Yes |
| Woven fabrics | Yes | No | No | Yes |
| Non-woven fabrics | Yes | Yes[2] | Yes[2] | Little |
| Grid + non-woven fabric/reinforced fabric | Yes | Yes[2] | Yes[2] | Yes |
| Sprayed membrane | Yes | Yes | Yes | No |

Table 1. Benefits of SAMI/asphalt reinforcement systems

Notes to Table 1

1. As compared to bond without the SAMI/reinforcing layer.

2. When laid in a fully impregnating bond coat. With self-adhesive materials, this will depend on the particular material and its bond both to the substrate and to the overlay.

3. Refer to manufacturer's data for actual strengths; generally steel grids provide most, synthetic grids less, and fabrics less again.

**Suitable sites for the introduction of a SAMI/asphalt reinforcement**

The circumstances where these materials provide most benefit include:

1. Over cracked or heavily reinstated surfaces where simple overlay tends to be vulnerable to reflective cracking. All cracking other than hairline cracking is detrimental to the structural condition of the pavement. It reduces the strength and lets in water. The water can freeze leading to more damage, fragmentation and delamination, and ultimately to complete failure. In more severe cases where the cracking extends through the full depth of the bound layers, water ingress can lead to softening of the foundation and even to mud pumping whereby fine material is pumped up to the surface.
2. Roads over poor or uneven foundation where settlement and subsequent cracking is a problem. It is accepted that a reinforcing layer in itself does little to reduce settlement,

but over poor ground it can greatly reduce cracking and subsequent failure, particularly if combined with a suitably flexible surfacing material.

3. Over the joint where a carriageway is being widened or extended, and thereby vulnerable to future cracking, a strip preferably at least 500 mm each side of the joint.
4. Over joints and cracks in older concrete carriageways where simple overlay tends to be vulnerable to reflective cracking. A SAMI cannot absorb significant vertical movement, but it can help accommodate a small amount, the performance being improved by use of a double layer of reinforced fabric at least 500 mm (up to 1200mm) wide laid in bond coat. The alternative in this situation may be saw cut and seal, provided the cracks are discrete and reasonably straight.
5. On steep gradients or tight radii subject to heavy commercial traffic where inter-layer stresses are high, an appropriate SAMI/reinforcing layer can enhance bond and reduce the tendency for the surface course to tear or crack.
6. Appropriate systems may be installed as a complete road repair system over the entire surface or as specifically needed over discrete areas or individual cracks.
7. In considering the incorporation of a SAMI/reinforcing layer, due account must be taken of its affect on subsequent maintenance operations. It is also vital that the incorporation of such a layer is properly recorded and its presence and function are taken into account in any subsequent excavation of the carriageway. This is particularly important in the event of utility operations.

**Recommended thickness of overlays**

1. The thicker the overlay, the longer the time before reflective cracking becomes evident. This is because structural movement in the base is reduced by load spreading and thermal movement is reduced by the insulating thickness. If an overlay thickness greater than 160mm is being provided, a SAMI will not normally be justified against reflective cracking, but it may provide a reinforcing benefit over poor ground.
2. The depth of overlay will be as designed for the structural requirements or the restraints imposed by the particular site, but as a minimum must be compatible with the reinforcing material used. It is generally preferable to place the material as low as possible in the resurfacing layers, though a regulating layer may be needed first. ( See below)
3. It is not possible to lay a regulating scratch course (which tapers out to nothing in places) over the reinforcing material as it would then be vulnerable to damage by the paver. Any scratch course and indeed normally even a full width regulating layer will be placed below the SAMI, which will then be overlaid by a full width layer. The minimum overlay is typically 40mm over a woven or unwoven fabric or spray system, 50mm over a reinforced fabric, 60mm over a synthetic grid, and at least 70mm in two courses over a steel grid, preferably more.

**Preparation and laying procedure for SAMIs/asphalt reinforcement**

1. **To obtain satisfactory results, proper preparation is necessary as is suitable weather. Such circumstances tend not to be compatible with winter work or rushed work at the end of the financial year.**
2. The SAMI/reinforcing system to be used must be carefully chosen, consideration being given to the strength and condition of the pavement, and the particular problems to be addressed. Consider also the laying circumstances; will a full carriageway possession be available, or only a partial one with traffic being accommodated past the works. This will clearly affect the choice of width of material utilised or cutting to be carried out.
3. The surface to be overlaid must be clean, adequately level, and adequately dry (see 5 below).
   a. Whether a grid or a fabric is being used, it must be in close contact with the surface. Excessive undulation prevents this, and it may be necessary to regulate the surface first.
   b. If the texture of the surface is too open or uneven, for example, very open textured, heavily weathered or fretted bitumen macadam or heavily pitted HRA;
   it may accept a plain grid stapled down, but adequate strength of fixing can be difficult to achieve;
   a woven fabric will not achieve adequate contact to bond properly;
   non-woven fabrics and sprayed systems can adapt to greater unevenness but still have their limits.
   c. A milled surface will normally need regulated if any system other than a non-woven fabric or a spray is being used.

   In these cases, levelling with fine bituminous material is necessary, e.g. asphalt concrete 6 dense, HRA 0/2, or HRA 50/10
4. It is also appropriate at this stage to carry out any patching and to reconstruct any particularly soft areas, taking into account that no system can accommodate more than very minor differential vertical movement across a joint or crack.
5. Where a bond coat is needed, straight run bitumen is quickest and most effective. While it is preferable to have a dry surface, some dampness may be accommodated, but too much and bond is compromised. Straight run also gives rise to some safety concerns, but with it, the fabric and the overlay can follow immediately on the binder. The alternative is bitumen emulsion which can tolerate a small amount of humidity and ground dampness (not wet), but it must be allowed to break before the fabric is laid, and hence at the very times when it is preferred because of the weather, it creates a delay of up to 30 or 40 minutes. Cut-back bitumen should not be used as the volatile oils cannot dissipate adequately through the overlay.
6. The rate of spread of bond coat must also be carefully considered. With fabrics, whether woven or unwoven, whether backed by a grid or not, full penetration is required, otherwise bond will be compromised. With unwoven fabric, the starting point would normally be about 1.1 l/sq m of residual bitumen (or otherwise depending on the manufacturer's instructions), but this will be adjusted down on a very fat surface, and increased over an open surface which would tend to absorb the binder. Full penetration

is not necessary when the fabric is first laid as the hot overlay will tend to draw the binder up thereby achieving full penetration at that stage (full penetration when fabric is laid would lead to great difficulty in the overlaying operation). If in doubt, the rate of spread to achieve full penetration and proper bond must be established by testing.

7. Some reinforced and plain fabrics are self adhesive, and full penetration and bond to the overlay is achieved by over-spraying which is then protected by chipping.
8. The material must be laid flat and any wrinkling or rucking avoided. It will be possible to pull some materials round slight bends, but at sharper corners it is necessary to cut and lap it, with extra bond coat if appropriate. If wrinkling or rucking occurs, it must be dealt with by cutting and lapping the surplus material, with a further layer over the joint if needed to provide the appropriate lap, and all layers properly stuck down.
9. The specified overlaps must be achieved at all transverse and longitudinal joints, normally 150mm for fabrics and up to 300mm with grids. Particularly where tensile strength is being utilised, laps must be adequate to provide continuity of that strength. With steel grids, the lapped joints should be wired together to avoid movement and separation, whether during tensioning or later when in service. Note: Shovels-full of 'fluxed macadam' or 'bitmac' do not provide the necessary strength!
10. Steel and certain polypropylene grids are pretensioned by stretching before fixing down whereas other synthetic grids and fabrics are merely laid taught, achieved by a simple braking mechanism on the laying rig. When laying self adhesive fabric or in a bond coat, it is necessary to have brushes or a roller fitted to the rig to ensure full and immediate bedding and hence adhesion of the material. Further rolling should be carried out as specified.
11. The reinforcing material will be trafficked by the laying rig, by the overlay paver, and by the delivery lorries. Care must be taken to avoid damage to the material by these or any other vehicles, whether by harsh braking, turning, or even by the force generated by the spreader pushing the delivery lorry. The stapled down grids and certain composite fabric/grid systems are particularly vulnerable to damage by moving and rucking at this time, and it is sometimes necessary to spray and chip or to lay asphalt ahead by shovel to protect the material from the wheels of the paver.
12. In order to avoid damage or compromising bond by introduction of rain, dirt; traffic, or otherwise, the SAMI/reinforcing layer should be overlaid immediately (that is, within the same working shift) after installation.
13. Details of the information to be supplied by the installer prior to and during installation, and the installed performance tests are given in Appendix A

Note; this guidance is of general application. In using any particular material, the manufacturer/suppliers instructions must be followed.

## Appendix A

**Information to be supplied prior to installation**

The geosynthetic products used shall have CE Marking to BS EN 15381:2008 *Geotextiles Characteristics for Use in Pavements and Asphalt Overlays.*
Product information shall give details for suitable asphalt overlay materials, minimum air/surface temperatures, permitted maximum temperatures, and minimum overlay thickness so that no defects are introduced in the surface
A detailed method statement shall be supplied giving the following information and such other site specific information the installer believes necessary

Risk assessments and Health and Safety information

Staff Competency

Details of training and competency of supervisors and operatives; e.g. CSCS Cards and NVQ.

Traffic Management details

All traffic management shall comply with Chapter 8 or the Safety at Street Works and Road Works CoP, and be installed by operatives operating to NHSS 12A, B, or D as appropriate.

Surface Preparation

The acceptance parameters of the surface on which the product is to be laid with respect to roughness, dryness and methods for cleaning and if necessary, drying
Resealing existing joint or cracks and time before SAMI/reinforcing layer can be applied
Treatment of ironwork

Installation (as appropriate)

The installer shall inspect the site prior to installation and confirm that it is suitable for the application of the system and that the material type and thickness of overlay is appropriate for the product.
Any special instructions necessary for the site team

**Bond coat**

Details of calibration certificates for bond coat spray device
Bond coat details by reference as appropriate to the parameters given in
EN 12591, *Bitumen and bituminous binders — Specifications for paving grade bitumens,*
EN 13808:2005, *Bitumen and bituminous binders — Framework for specifying cationic bituminous emulsions,* or
EN 14023, *Bitumen and bituminous binders — Framework specification for polymer modified bitumens.*
Bond coat material shall be CE marked
The method for determining rate of spread of bond coat shall take account of surface porosity, treatment of edges and laps.

**Geosynthetic/reinforcing layer**

Method of laying including details of joints laps, coping with radii and ensuring intimate contact with road surface.
Methods of tensioning.

Methods of firmly attaching to the road surface.
Details of any protection or additional over-layer added above the SAMI/reinforcing layer to complete the System including testing required for control of the material and rate of spread.

**Details of control tests to be carried out during installation**
These shall at least include measurement of rate of spread of bond coat by, for example, carpet tile test or monitoring calibrated tanker, and measurement of additional over-layer.

**Tests to be carried out after installation**
At least two cores shall be taken per 500 sq.m from the finished surface or after the first layer of asphalt has been overlaid as dictated by the site programme. This rate may be reduced on the basis of consistent positive results. The coring shall be done carefully and ensure at least 50mm of the existing road pavement is included below the SAMI/reinforcing layer. With overlay thickness greater than 160mm, this test should not normally be needed.
The cores shall be tested in a UKAS accredited laboratory for shear bond using the torque bond test as described in the Guideline for Thin Surfacing and Tensile Adhesion Test as described in TRL 176
Tests results shall be provided in a timely manner

The minimum values required depend upon the thickness of asphalt overlay and are as follows (Based upon IAN 96Rev 1 *Guidance on implementing results of research on bridge deck waterproofing)*

| **Surfacing thickness** | **>120 mm[1]** | **120 – 90 mm[1]** | **90 – 60 mm** | **< 60mm** |
|---|---|---|---|---|
| Tensile adhesion test [2] | 0.30MPa | 0.50MPa | 0.70MPa | 0.8 MPa |
| Shear bond test[2] | 0.30MPa | 0.30MPa | 0.40MPa | 0.6 MPa |

Note 1. Where work is soundly executed, the higher values of bond should be readily achieved, and must be seen as beneficial regardless of the overlay thickness.
Note 2. Where significant braking or turning forces are expected or the SAMI used as part of a structural layer over a soft substrate, the values for 90-60mm surfacing thickness should be achieved
Note 3. Mean of 3 cores
Note 4. Well compacted asphalt layers and the bond between them will withstand these forces without destruction if properly laid and fully compacted. Should failure occur in or between the asphalt layers at values below these quoted, the asphalt installation is defective and may need replacement. It may be prudent to take additional cores in a case of doubt to enable the SAMI bond to be assessed.
Note 5. The installer may propose for consideration an alternative method of providing evidence of adequate bond in the completed SAMI/reinforcing layer system.